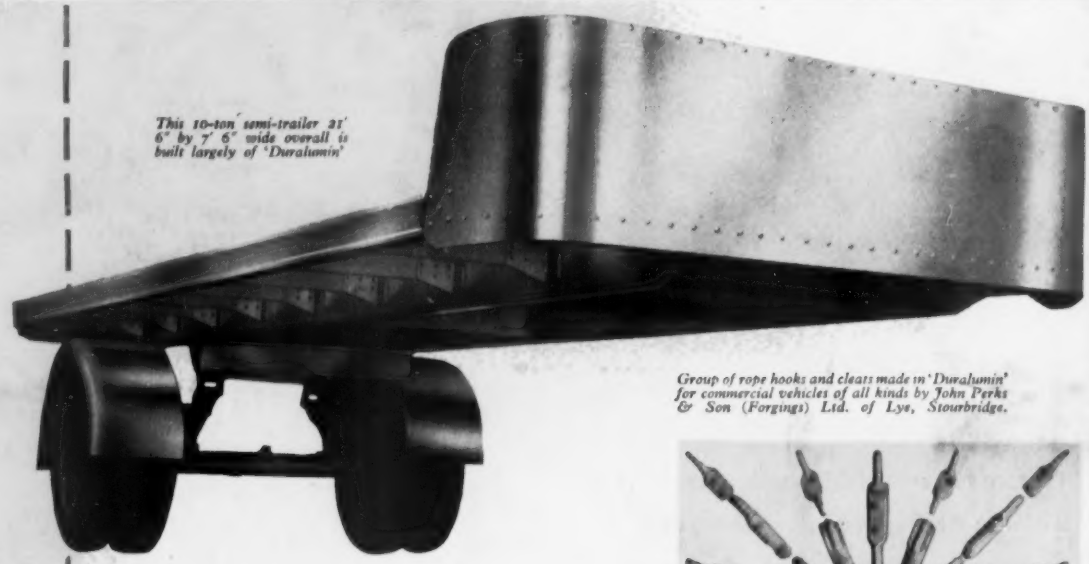
1955 LONDON SHOW REVIEW

AUTOMOBILE ENGINEER

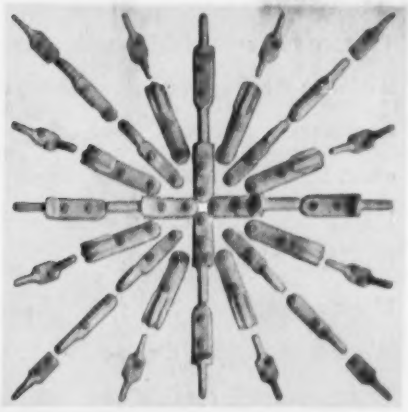
DESIGN · PRODUCTION · MATERIALS

Vol. 45 No. 12 NOVEMBER 23, 1955 PRICE: 3s. 6d.



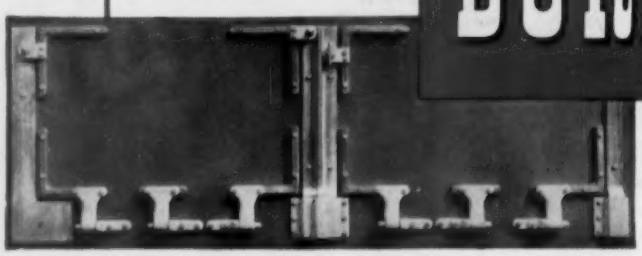
This 10-ton semi-trailer 21' 6" by 7' 6" wide overall is built largely of 'Duralumin'

Group of rope hooks and cleats made in 'Duralumin' for commercial vehicles of all kinds by John Perks & Son (Forgings) Ltd. of Lye, Stourbridge.



'Duralumin' extruded section and plate were specified for this robust trailer made by R. A. Dyson & Co. Ltd., Liverpool. The lightweight construction reduces tyre wear and fuel consumption while enabling pay-load to be increased. 'Duralumin', the best of aluminium alloys for all transport work, is only one-third the weight of steel, absorbs shock and cannot rust.

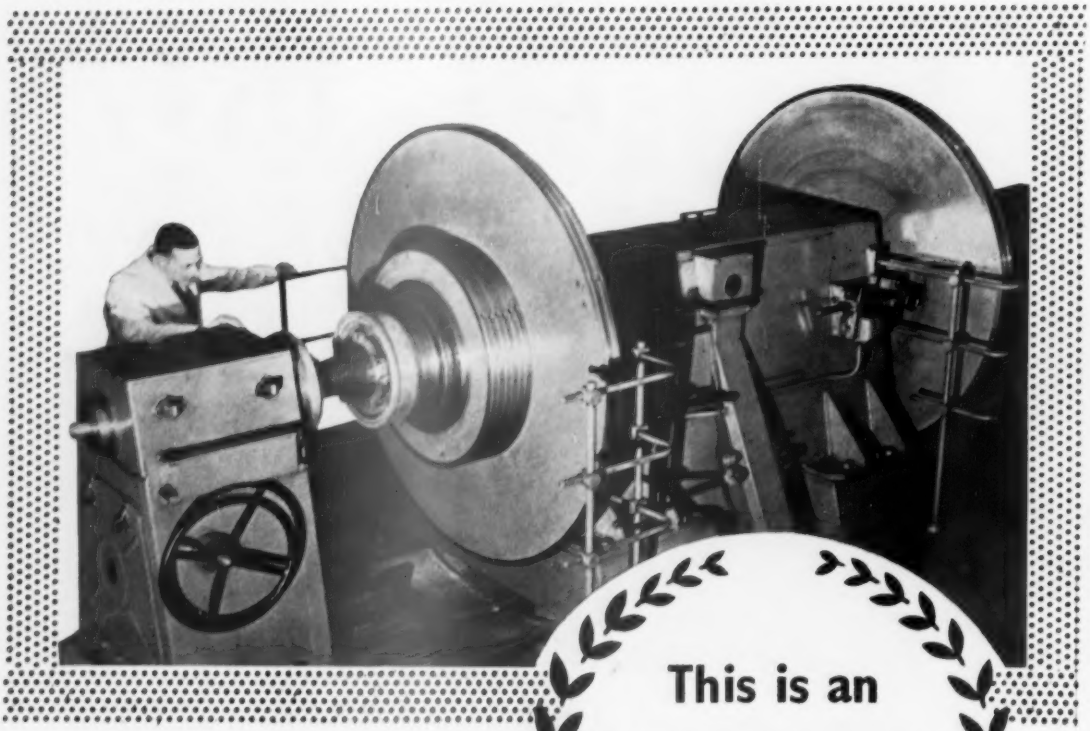
A selection of hinges, pillars, and bolt sections in 'Duralumin' for vehicle bodies. (Courtesy: John Perks & Son (Forgings) Ltd.).



DURALUMIN

JAMES BOOTH & COMPANY LIMITED
ARGYLE STREET WORKS, BIRMINGHAM 7

TGA 10769



This is an international race winner

The men who control this machine have never thrilled to the drop of a chequered flag or earned the applause of a crowd at an International racing event. But they are continuously playing a vital part in helping to win International motor races.

On this 18·5 million ft-lbs capacity Inertia Machine Brake Liners are subjected, in terms of kinetic energy, to stresses far in excess of anything they would have to endure on any race track.

To us, research is the chief essential of brake liner manufacture. Mintex leadership, in fact, is based upon our policy of solving the braking problems of the future before they arise.

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you can rely on MINTEX

MINTEX BRAKE AND CLUTCH LINERS ARE MANUFACTURED BY BRITISH BELTING & ASBESTOS LIMITED, CLECKHEATON, YORKSHIRE

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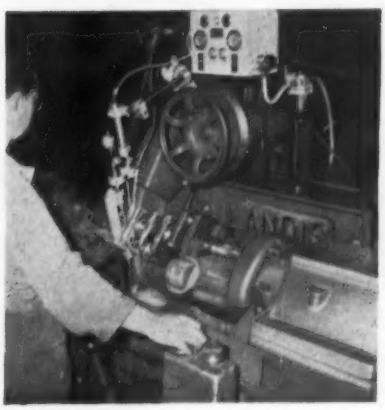
Air-operated GAUGING UNITS

FOR AUTO-SIZING & MACHINE CONTROL

Auto-sizing machine-control is the modern technique for the production of high-precision components.

With the Etamic air-operated unit, which is quickly and easily applied to any make of grinding machine, savings in production time up to 50% can be secured, with the complete elimination of rejects regardless of tolerance.



The Etamic unit automatically controls the machine in relation to the size of the component, allows for dwell or slow finishing cut, and automatically retracts the grinding wheel. Size-control is unaffected by wheel wear or age of the machine.

Etamic units are designed to permit traverse grinding; they are extremely robust yet of high measuring sensitivity; and can be used economically for single components or small batches.

ETAMIC Crankshaft Caliper on LANDIS grinding machine.

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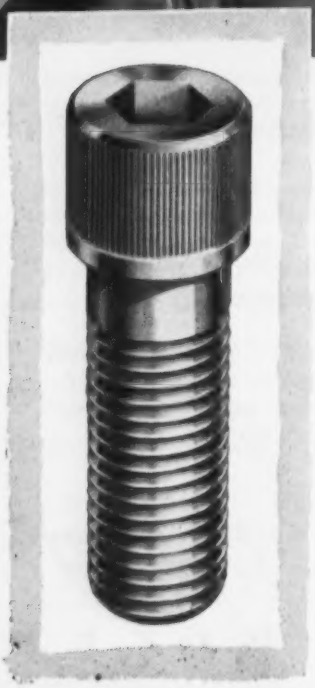
HAND TIGHT ?



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A calibrated wrench shows us that Unbrako socket screws will stand far greater torsional strain than other screws of the same size without distorting or breaking. Higher predetermined tightening torques can therefore be applied on assembly with subsequent assurance of increased resistance to slackening, and safety under conditions of dynamic loading.

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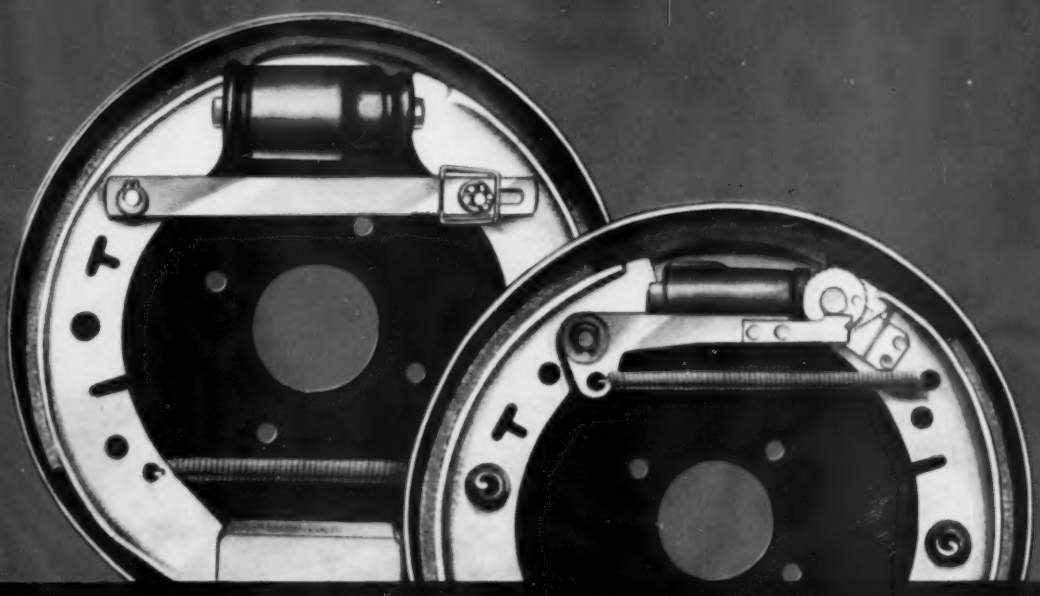

BRAKEMASTER

THE PRESENT DAY BRAKE PROBLEM

1 To give the maximum retarding power and fade resistance.

2 To obtain the highest possible stability.

3 To lessen the required pedal pressure, without overmuch dependence on servo action.

THE SOLUTION: The Lockheed Brakemaster

The use of trailing and leading shoes compensates for variations in coefficient, giving great stability. In the front brakes, which do two-thirds of the work, the braking effort from the trailing shoe is made to equal that from the self-energising leading shoe, by actuating it with a proportionately larger piston, so that both shoes do equal work and their linings wear equally. The rear brakes follow previous Lockheed practice, except that both they and the front brakes have new and highly efficient self-adjusters.

The servo is a simple vacuum booster based upon the extensive Lockheed experience of the type. In the event of engine stoppage, the hydraulic system functions in the usual way but with a somewhat increased pedal pressure.

The Lockheed 'Brakemaster' system has been chosen for the 2·4 litre Jaguar after exhaustive tests.

AUTOMOTIVE PRODUCTS COMPANY LTD., LEAMINGTON SPA, ENGLAND

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LOCKHEED: Regd. Trade Mark

LOCKHEED

Ideal transmission

Especially developed to suit the requirements of the ordinary British motor car, the Manumatic transmission system provides an efficient two pedal control and yet without needing any major alterations in the existing design. Used in conjunction with a normal synchromesh box, the Manumatic system incorporates an adaptation of the standard Borg & Beck clutch, with a tell-tale contact which, by operating simple servo units, operates the clutch and throttle to provide perfect shockless changes.

It is the ideal transmission for the British type of car and British roads.

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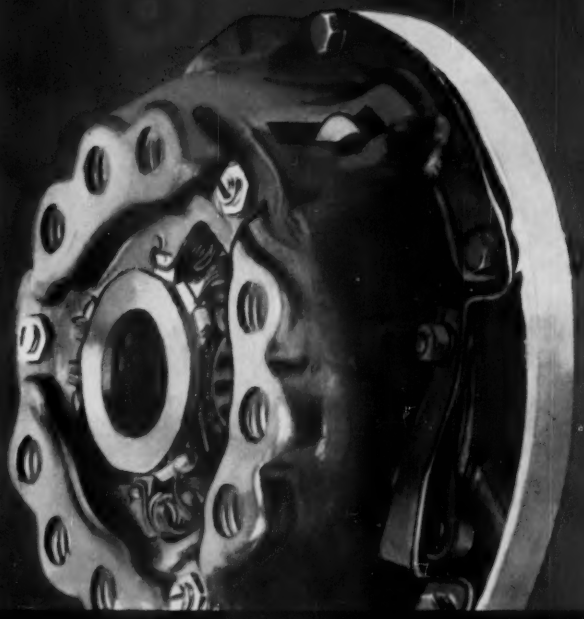

STRAP-DRIVE CLUTCHES

Borg & Beck clutches have gained their outstanding popularity by their constant development and continual refining of design. The recently incorporated strap-drive has proved so successful that it has been applied to a new range of clutches.

The Borg & Beck 8" and 9" A.S. Type Strap Drive twin-disc and single-disc clutches are designed specifically to cover a range of high performance engines. The torque range catered for by this series of clutches varies from 100 lb./ft. max. for the 8" single, to 300 lb./ft. for the 9" twin. These figures relate to normal passenger car applications with maximum speeds of 9,000 r.p.m. in the case of the 8" and 8,000 r.p.m. for the 9" size.

The drive to the pressure plate is taken by a series of tangential straps in the characteristic Borg & Beck manner; these give a silent drive, low frictional losses, and a high and consistent standard of balance in the clutch as a whole. Either a carbon or a ball-bearing release mechanism may be used.
There is in addition a full range of Borg & Beck 'A' type clutches.

BORG & BECK COMPANY LIMITED
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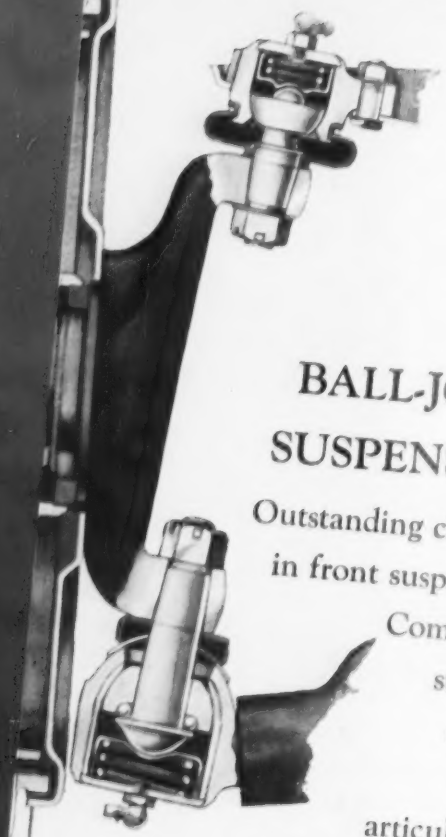

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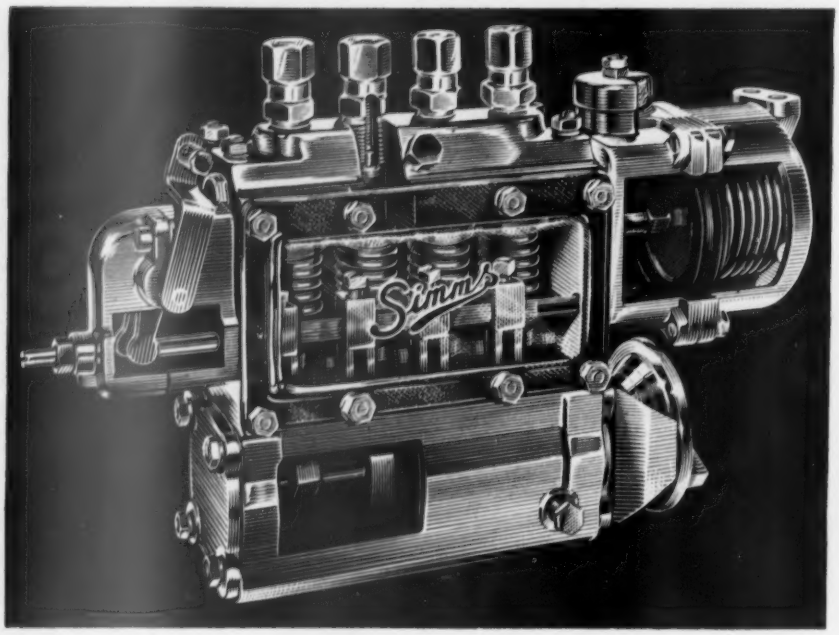

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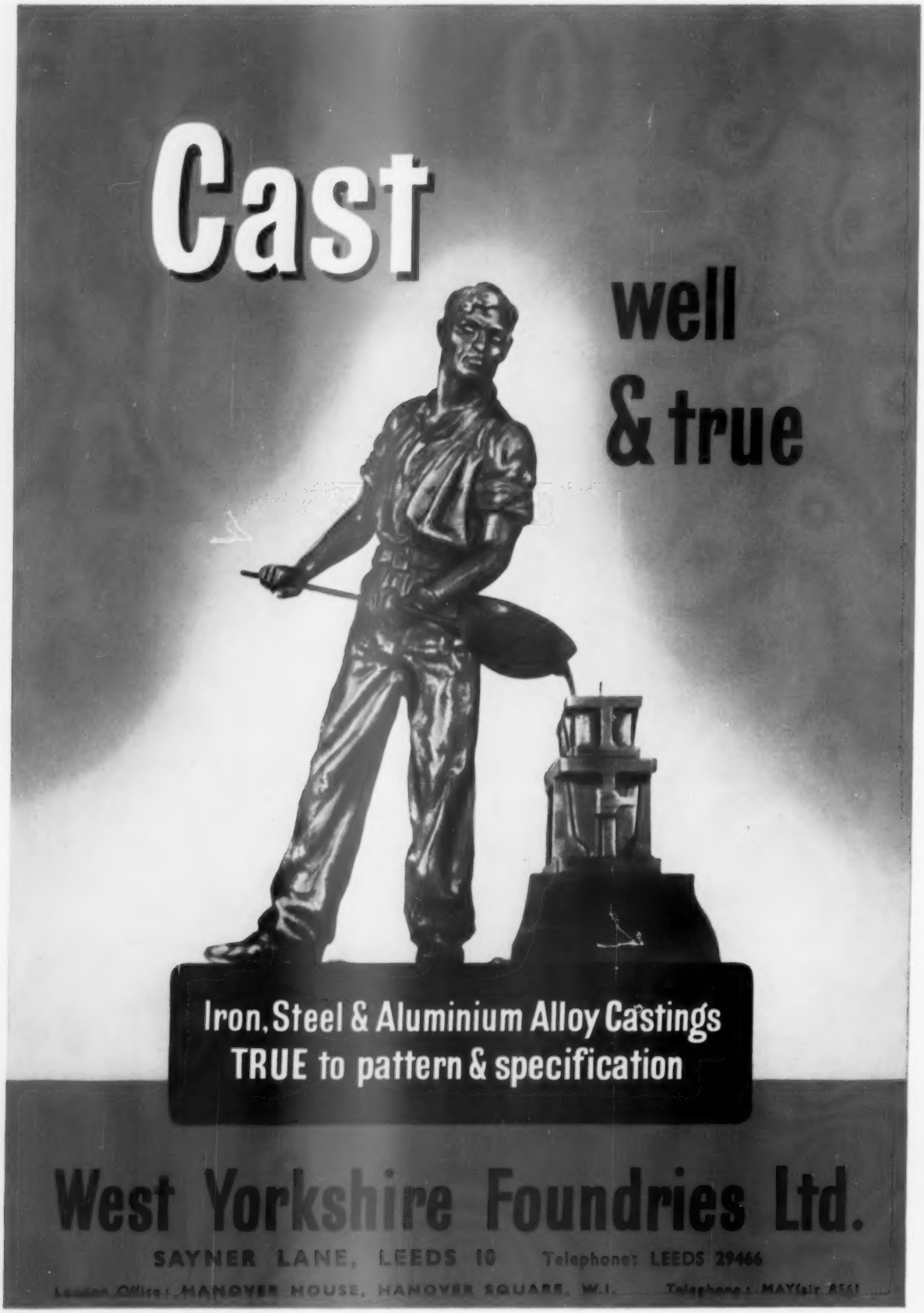
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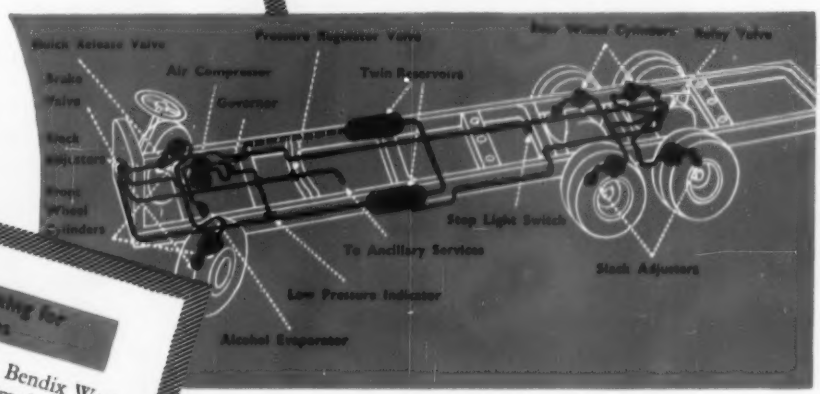

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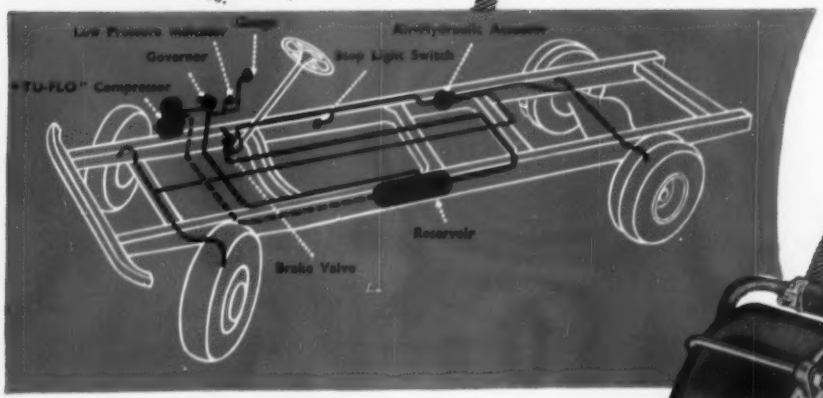
The latest development from Bendix Westinghouse. An extremely simple system, comprising air compressor — governor — reservoir—and air hydraulic actuator incorporating the hydraulic master cylinder. All units are lightweight, for example, the TU FLO 300 Compressor weighs only 14 lbs.



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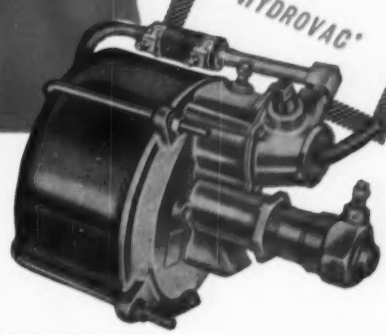

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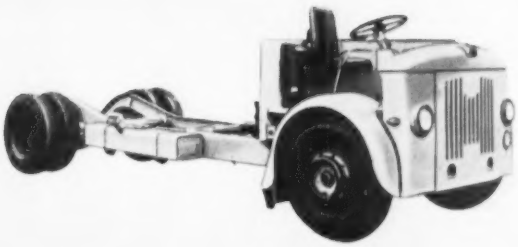

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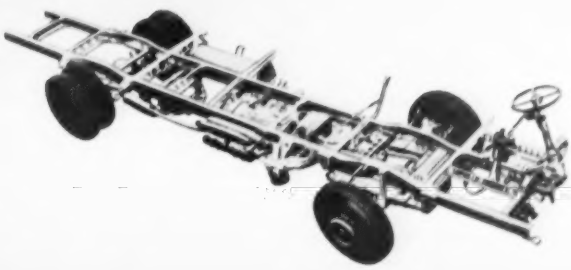

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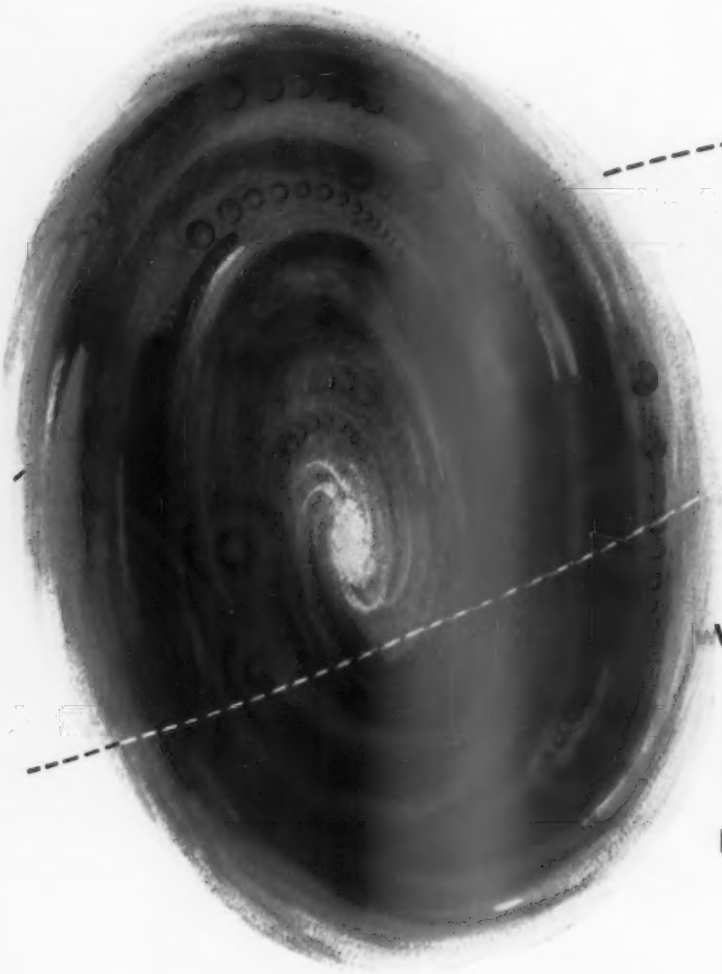

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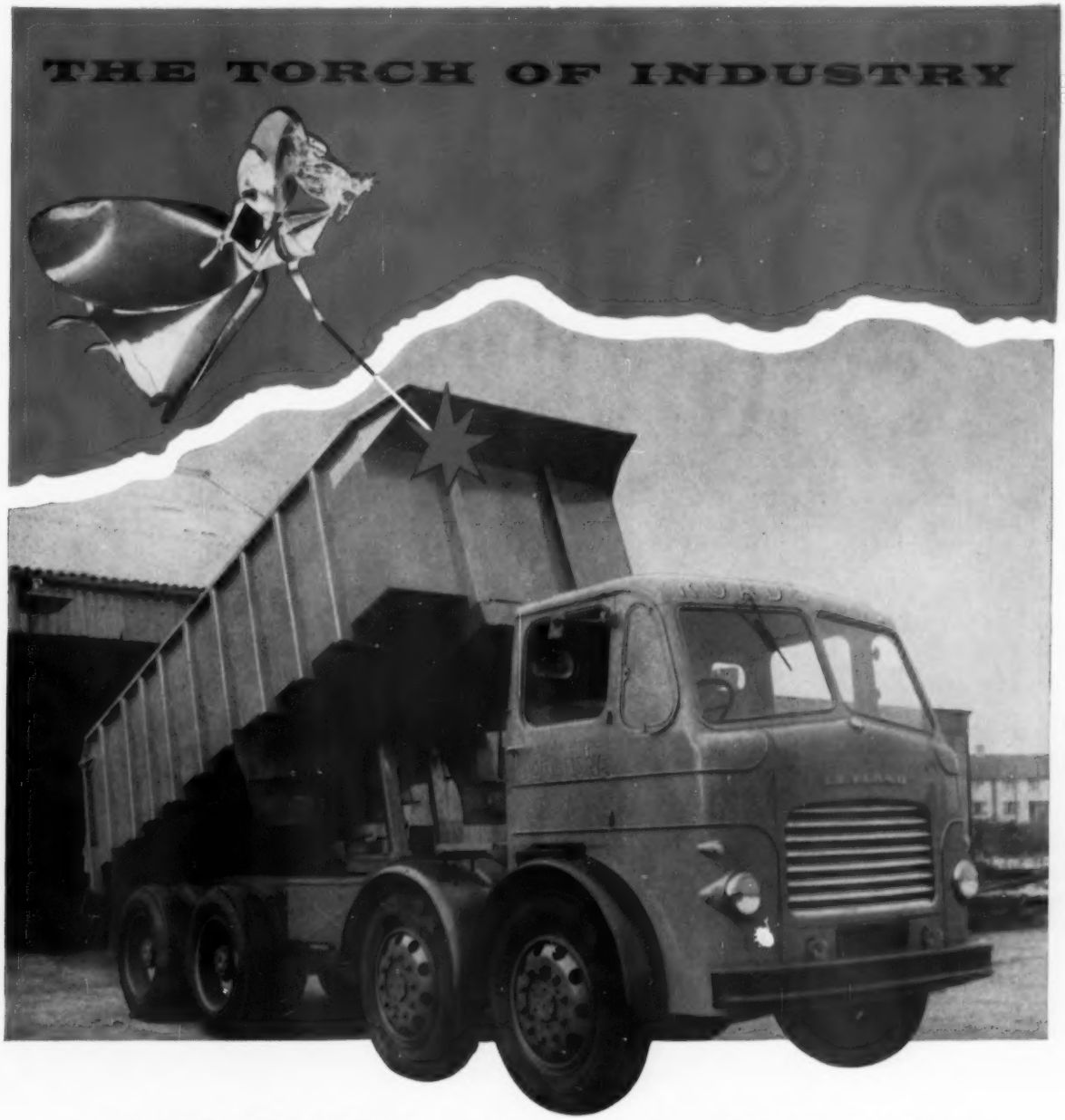

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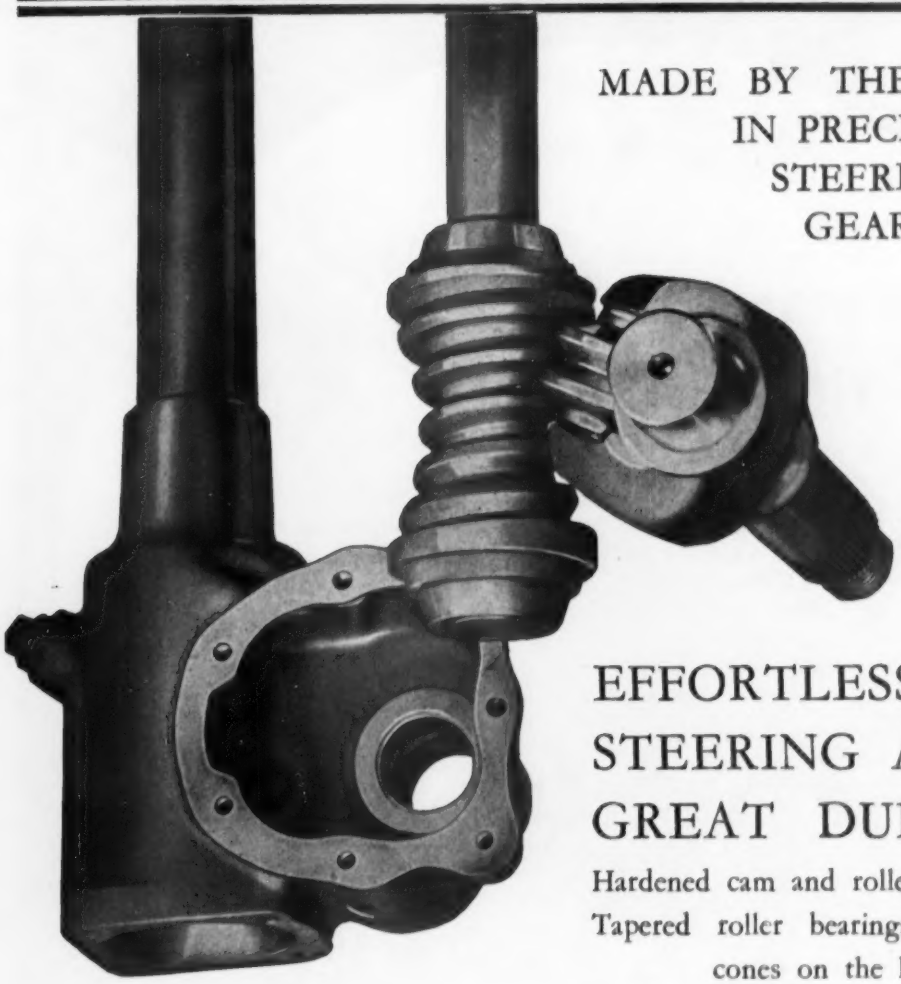

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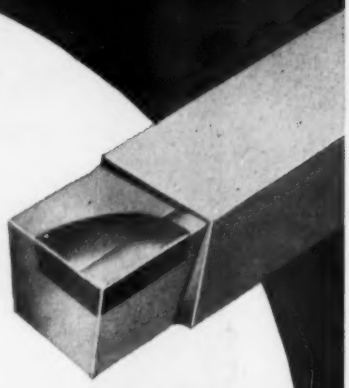

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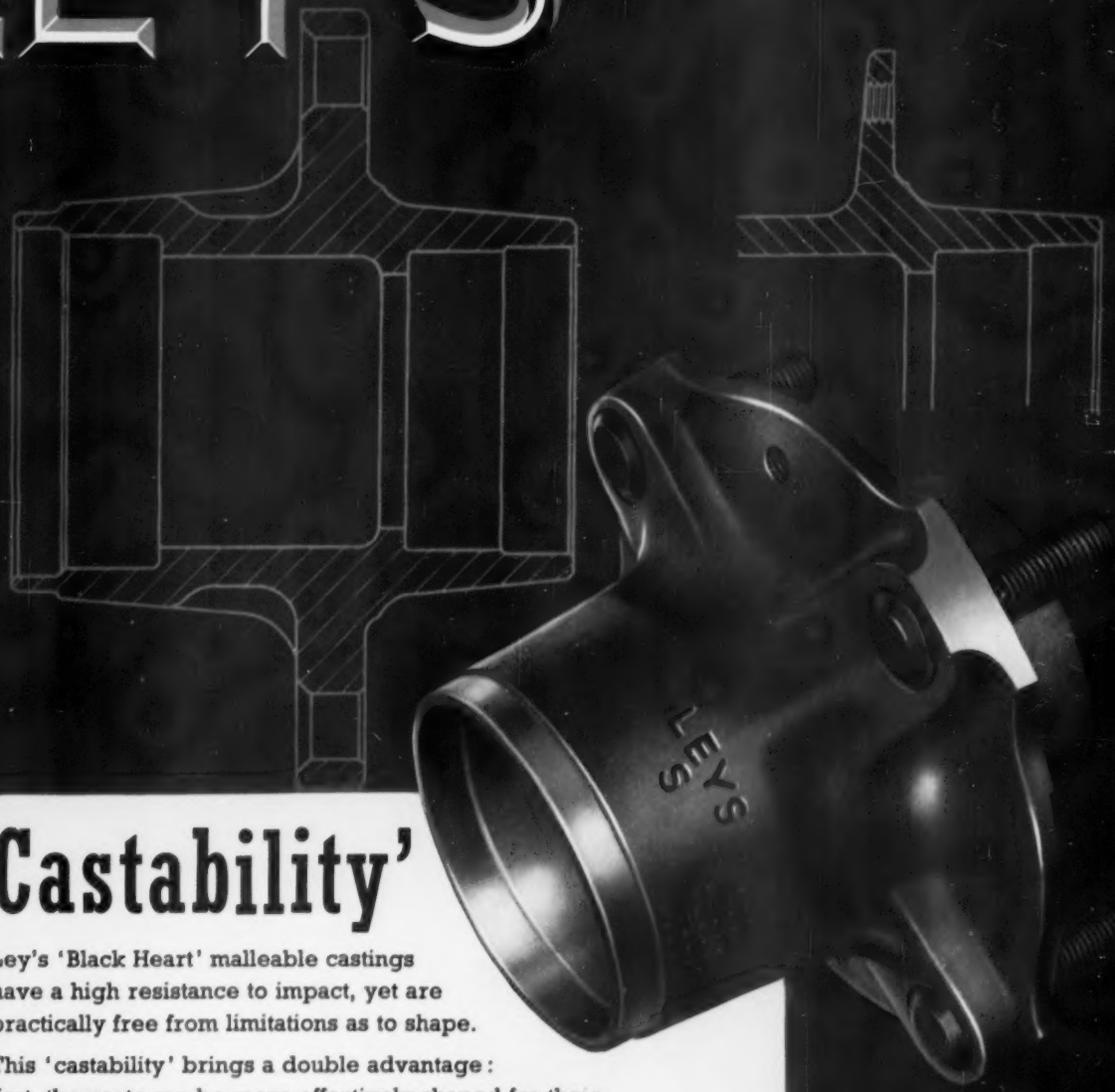

'Castability'

Ley's 'Black Heart' malleable castings have a high resistance to impact, yet are practically free from limitations as to shape.

This 'castability' brings a double advantage: first, the parts can be more effectively shaped for their ultimate purpose; second, this freedom from limitations generally means that less metal has to be removed.

Coupled with the easy machinability of Ley's 'Black Heart', these factors are a great manufacturing asset, moreover the finished part is better suited to its duties.

The illustrations show, actual size, the front hub of a popular car, made from Ley's 'Black Heart', completely machined.

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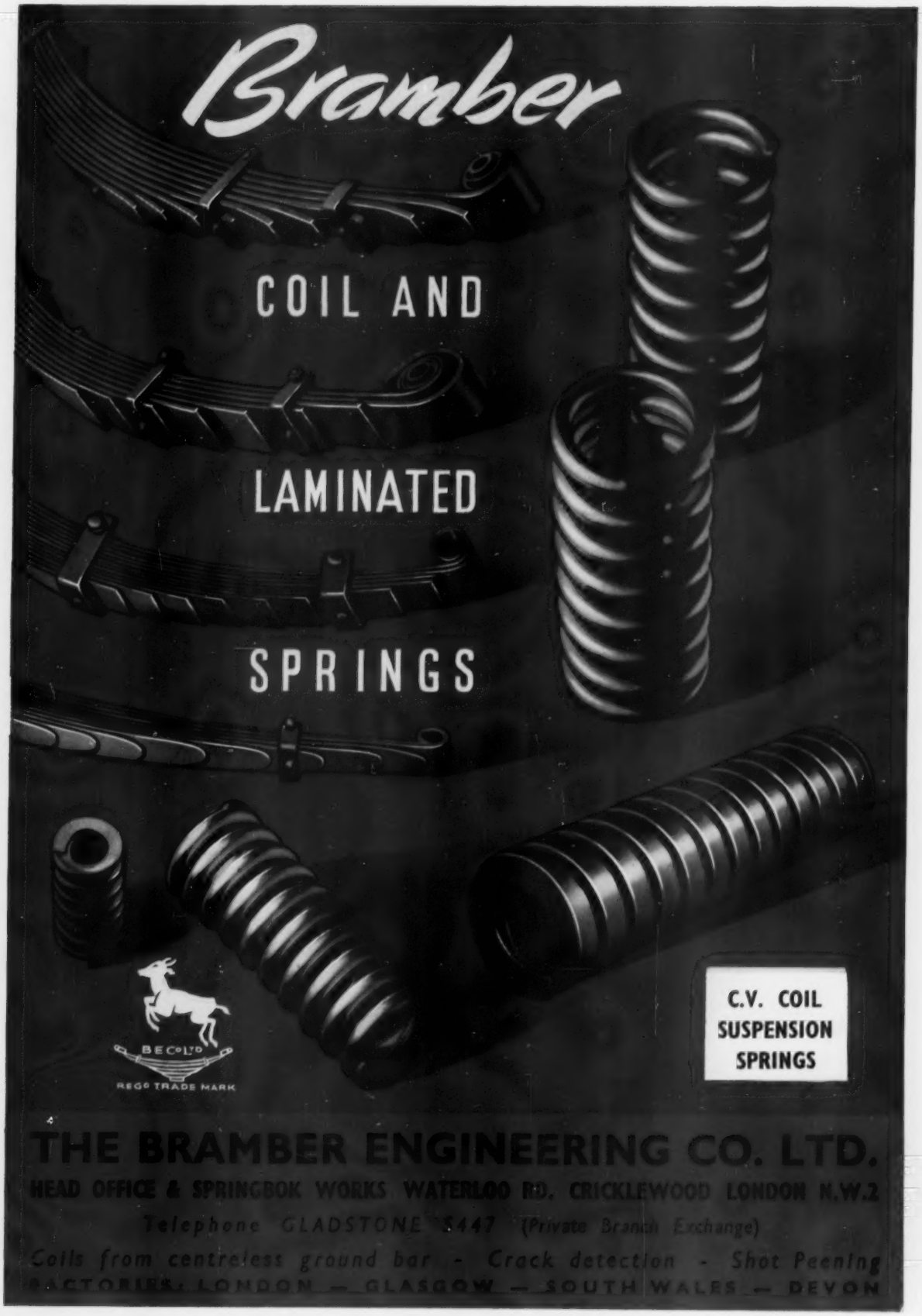
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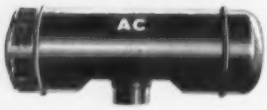

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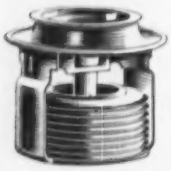

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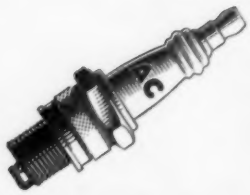

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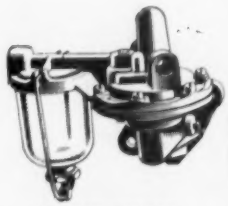

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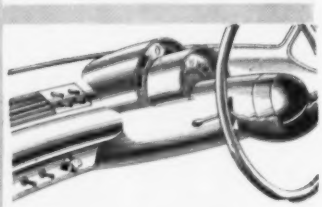

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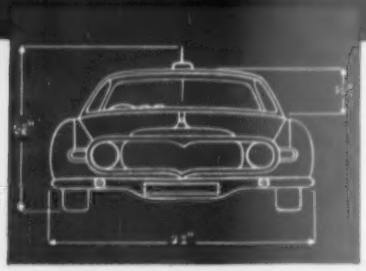

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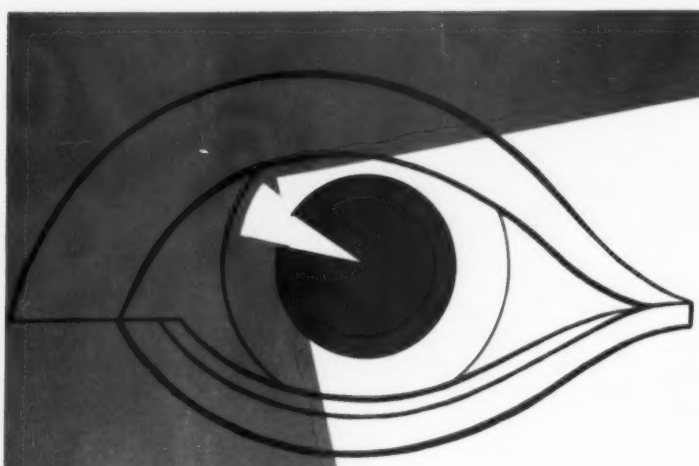

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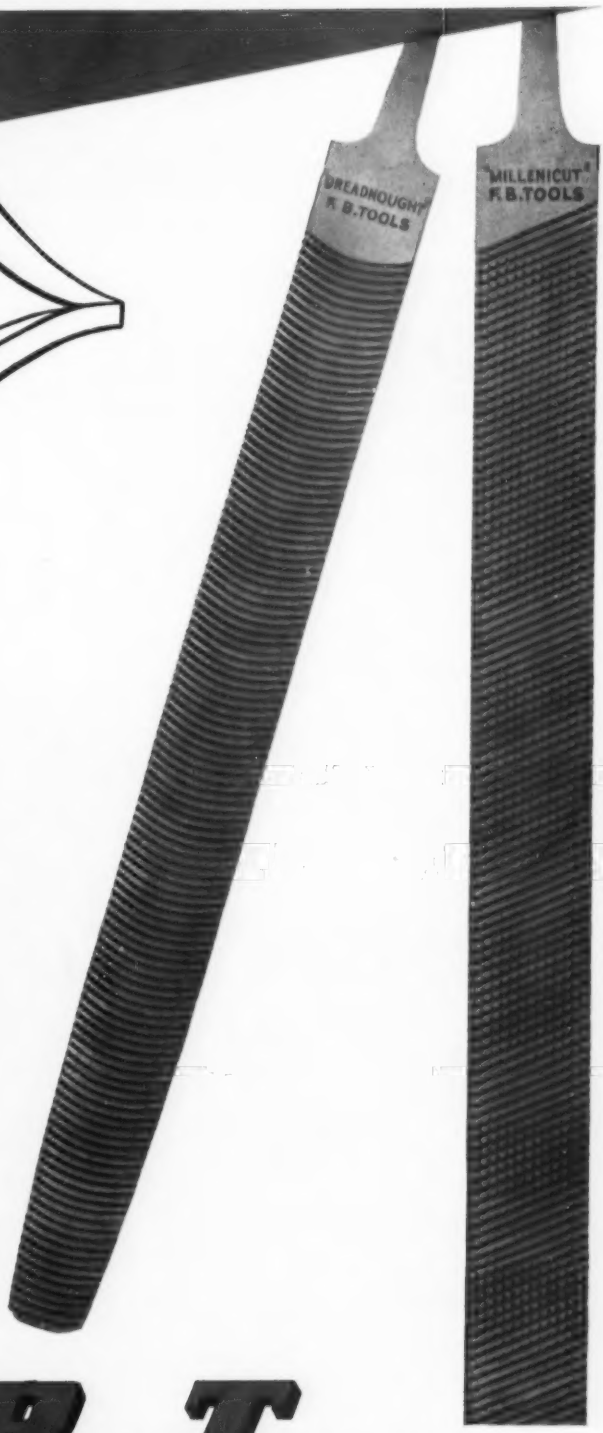

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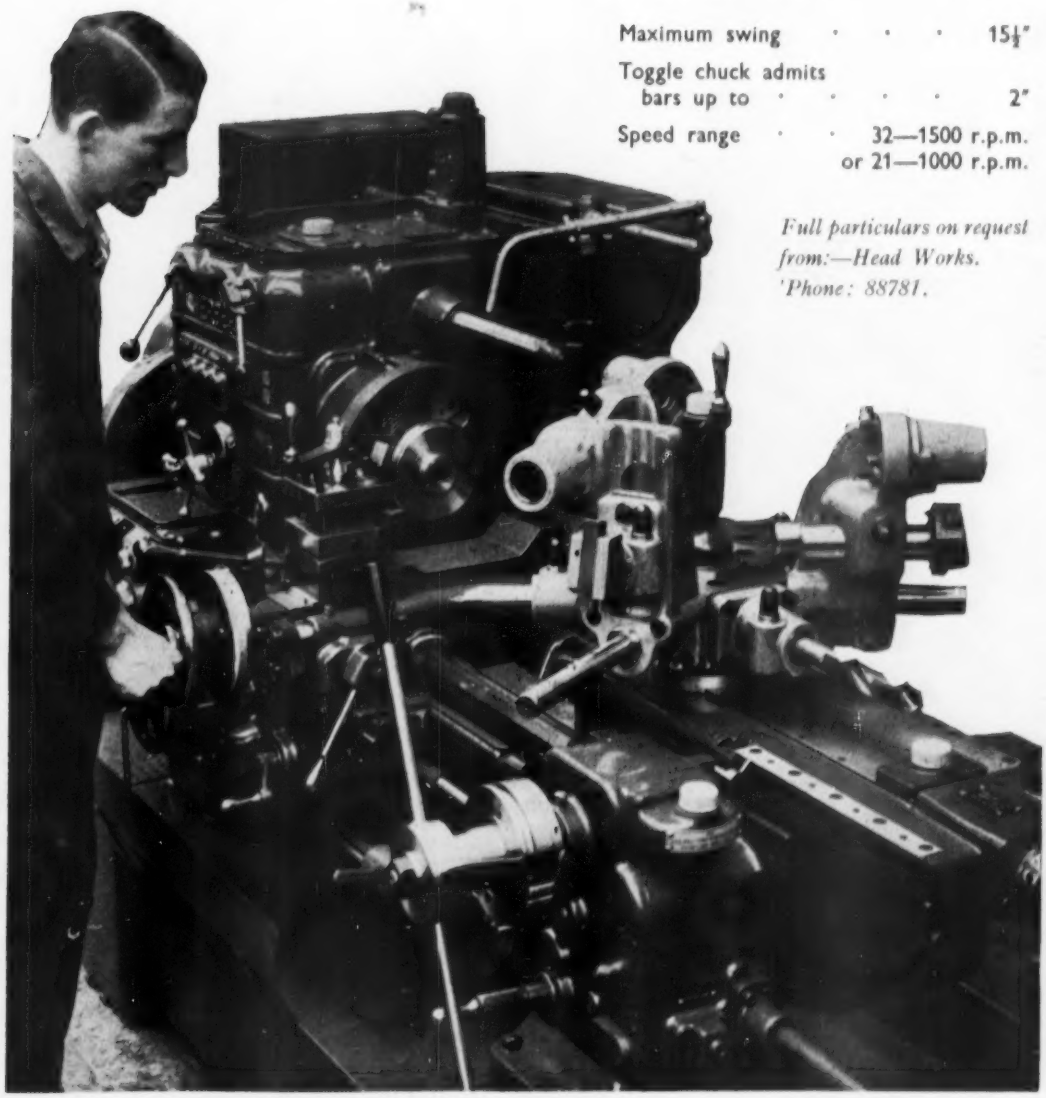

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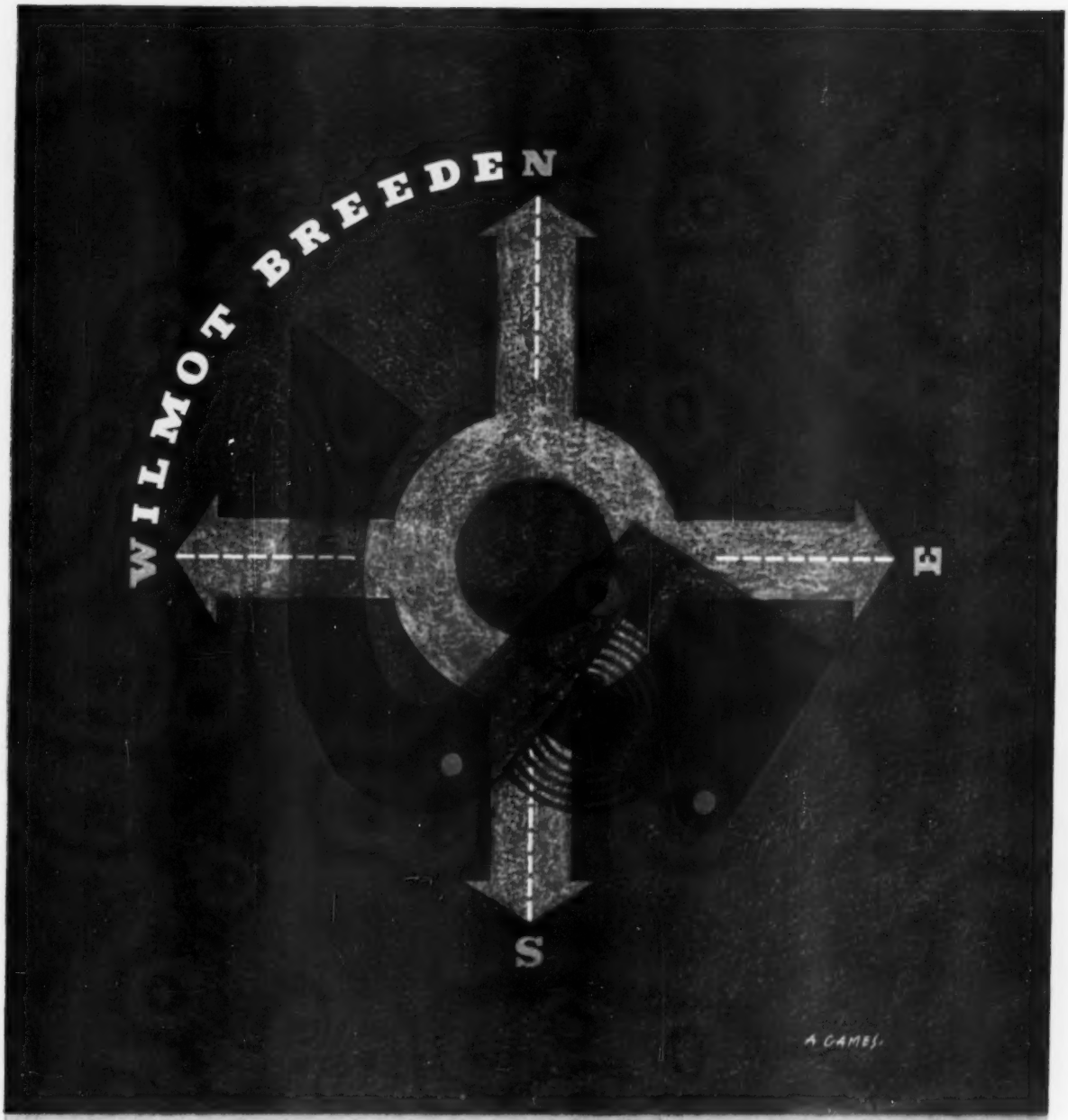

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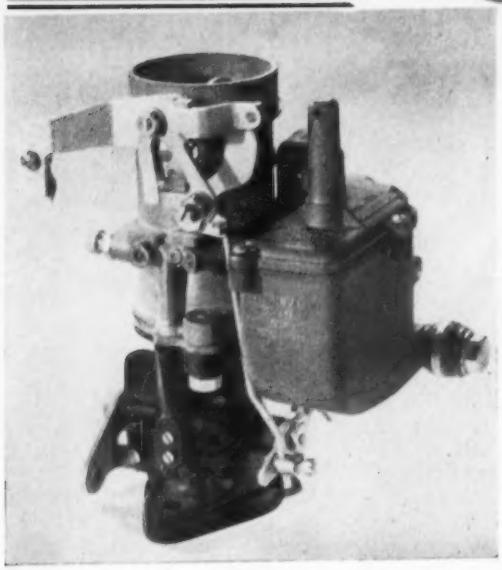

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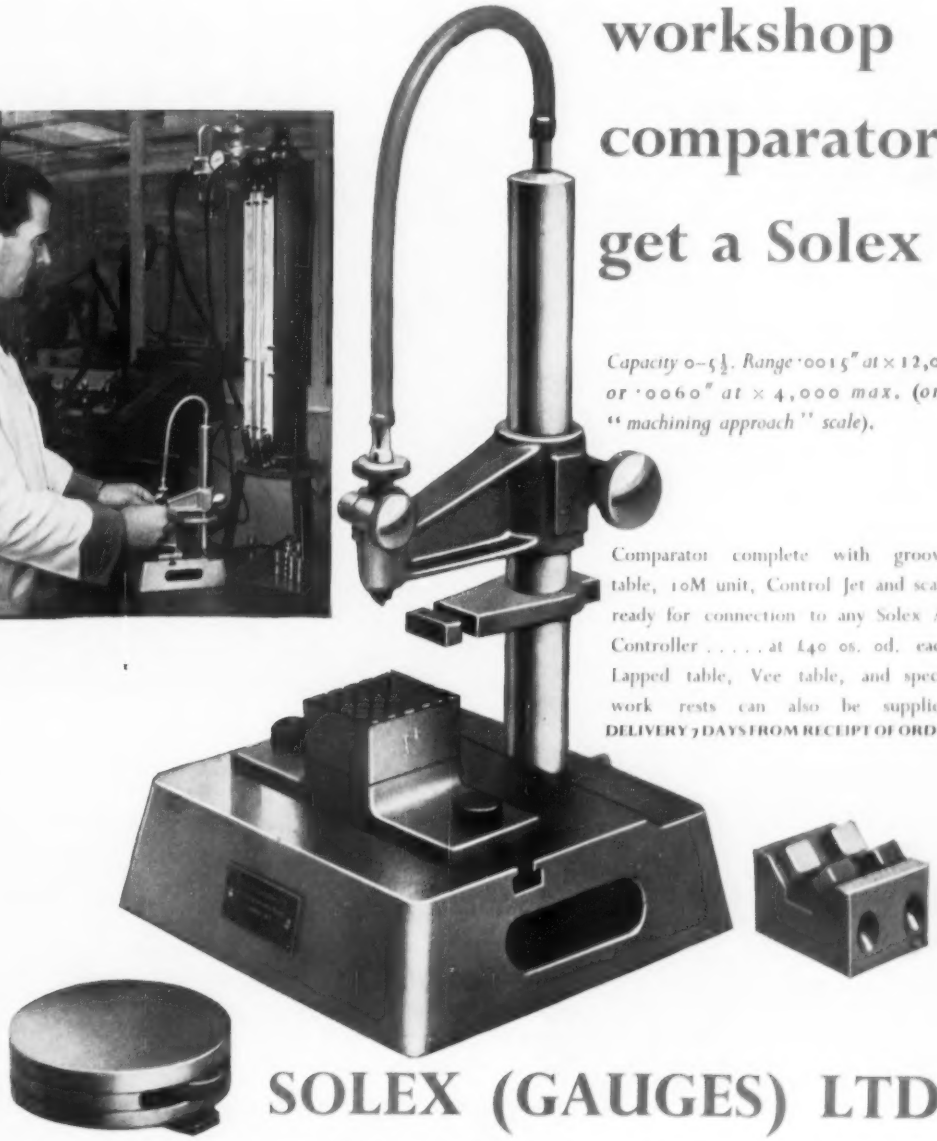

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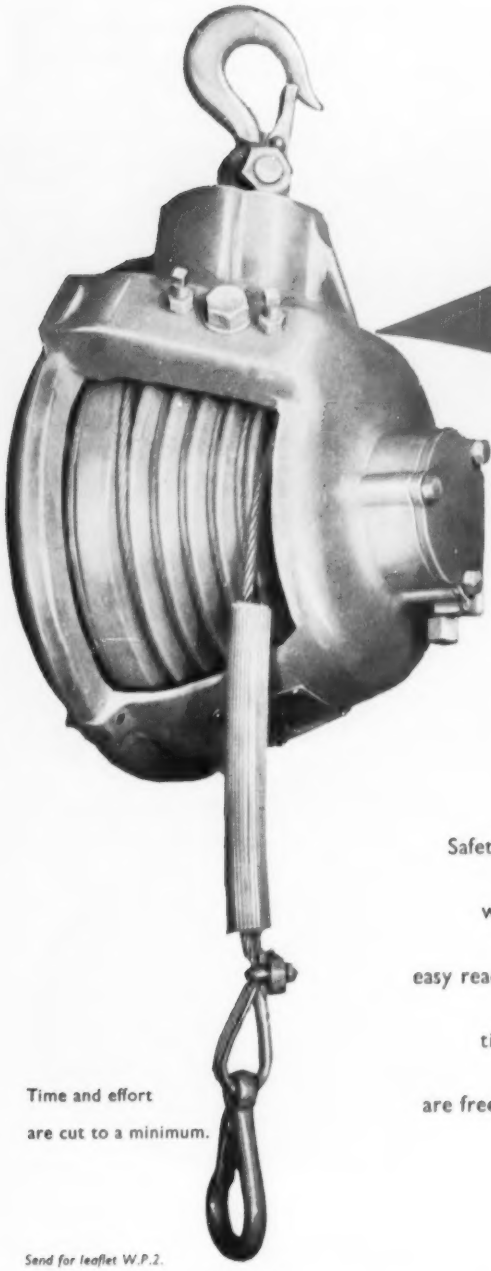

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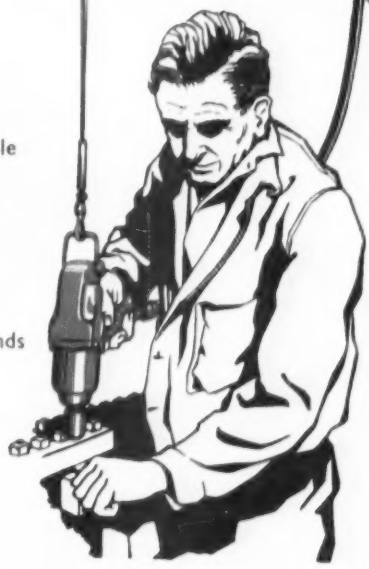

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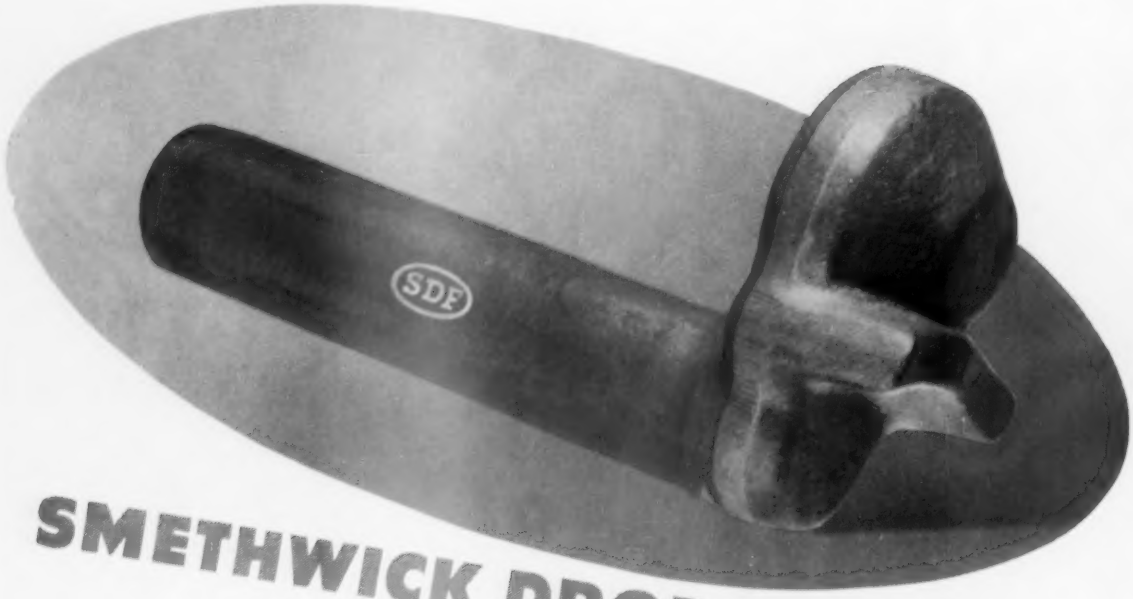

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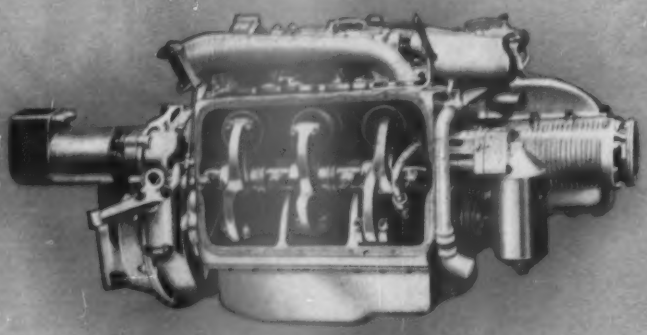

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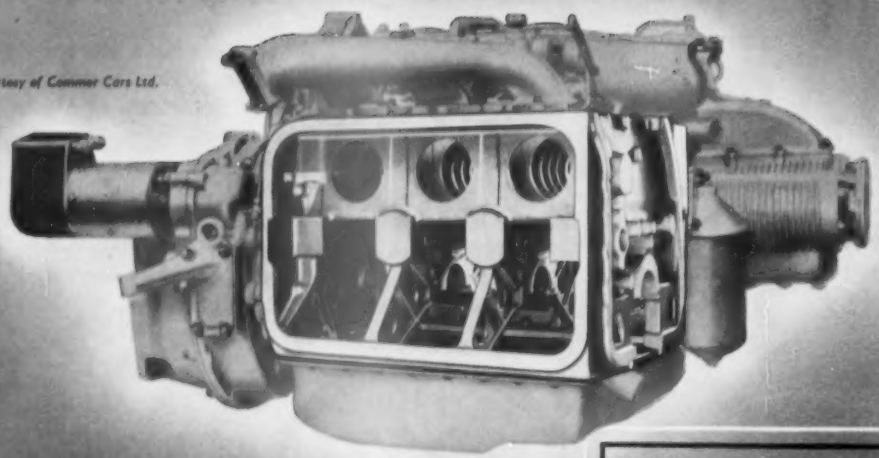

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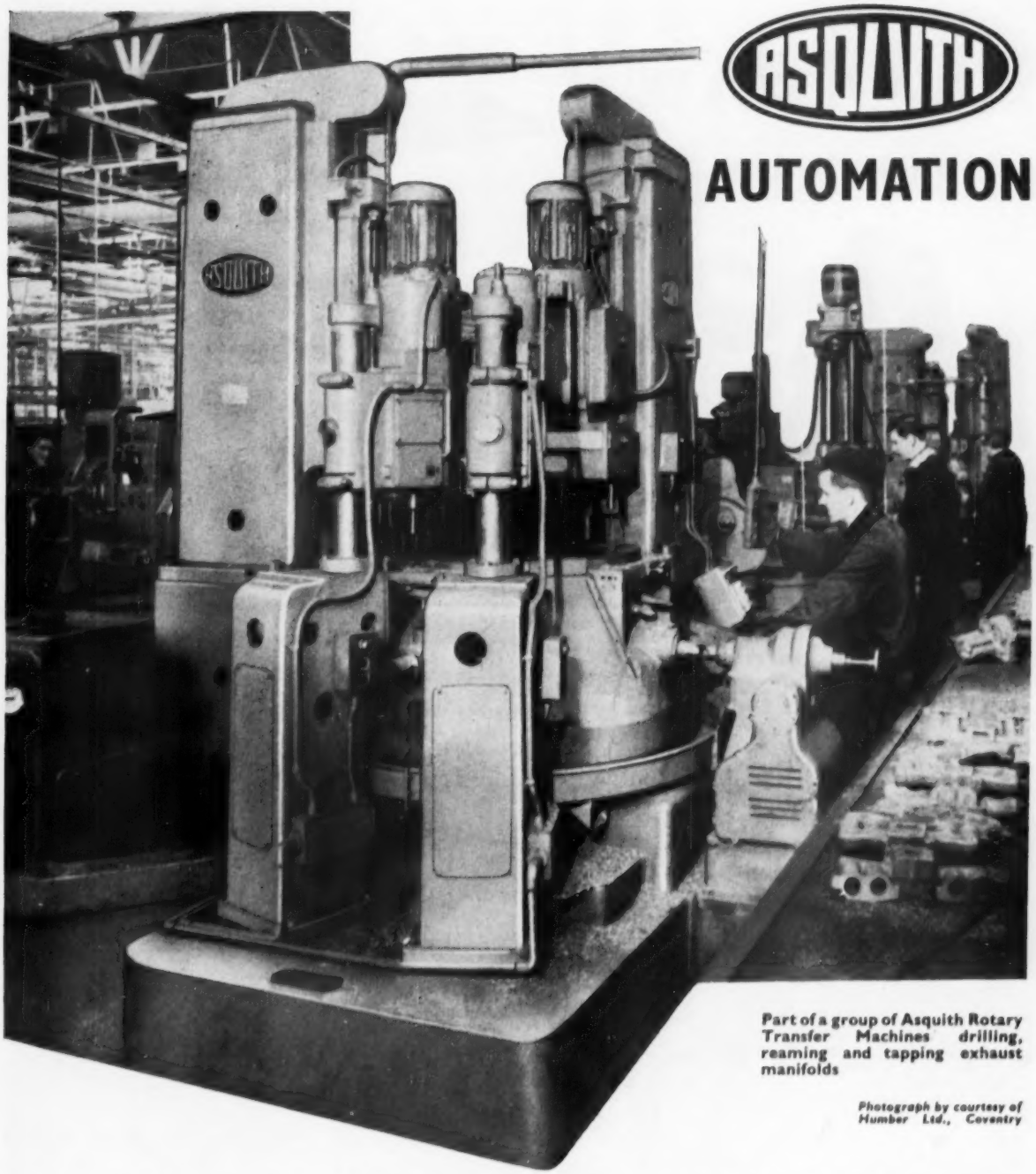

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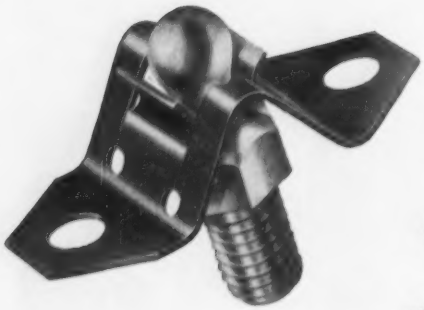

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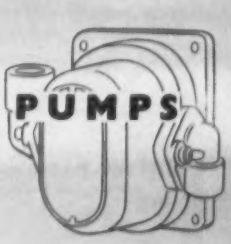

If you have a problem which involves hydraulic power, get in touch with Plessey—they may well be able to provide the answer—simply, efficiently and economically.

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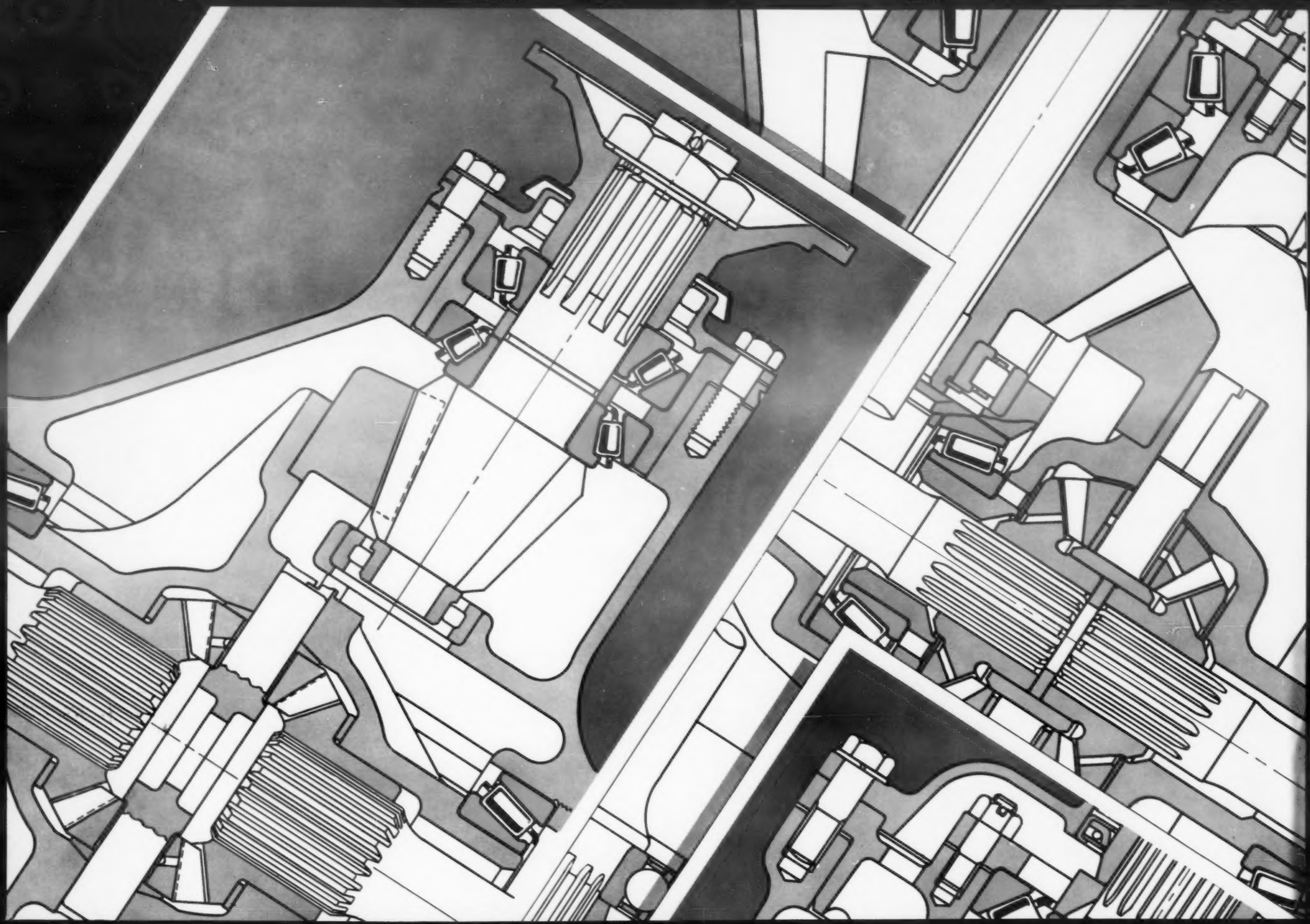

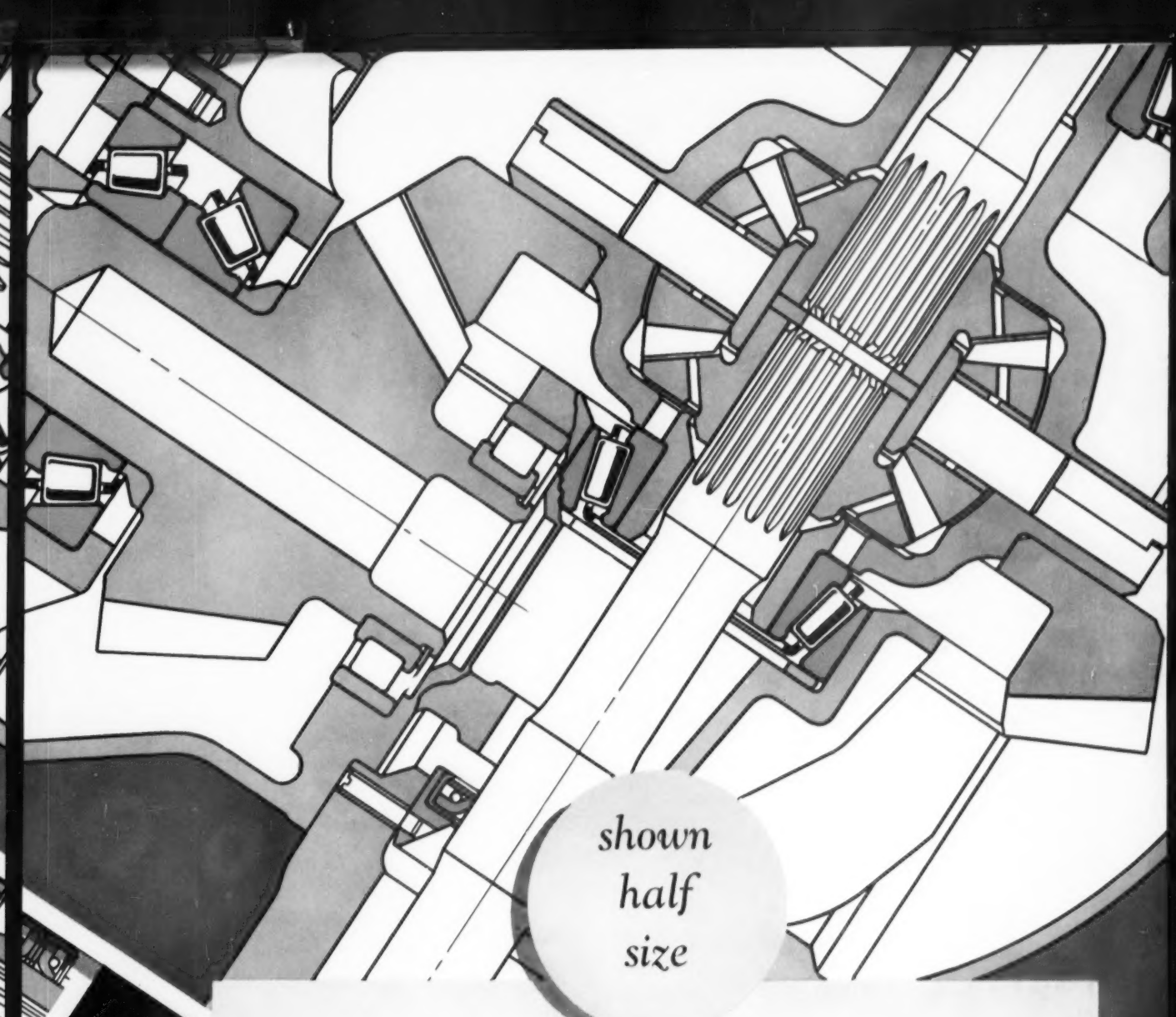

shown half size

Three large rear axles

These illustrations show three interesting axles equipped with Timken tapered-roller bearings. Below, at left, the axle of the A.E.C. 'Reliance' and 'Monocoach'. The two other views relate to the Kirkstall 24-ton twin-axle bogie. In this, the drive is taken first to a ' third differential ' balancing the drive between the first and second axle. One sun wheel of this differential gear drives the hollow hypoid pinion of the first axle, the other drives a shaft passing through this pinion to a universal shaft at the rear of the first axle and driving the hypoid pinion of the second axle, each axle of course having its own differential.

Advantage is taken of the offset, characteristic of the hypoid drive, to take the sun wheel shaft over the axle shaft, giving a neat solution to an old problem.

The use of standard and steep-angle Timken bearings is self-explanatory.

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Close limit forging...

Close limit forging of a compressor blade at the Works of Omes Limited, Barnes, S.W.13. ("The Aeroplane" copyright photograph).

..with MoS_2

Omes Limited, specialists in precision stampings for the automobile and aircraft industries, have been regular and enthusiastic users of **'dag'** dispersions for many years.

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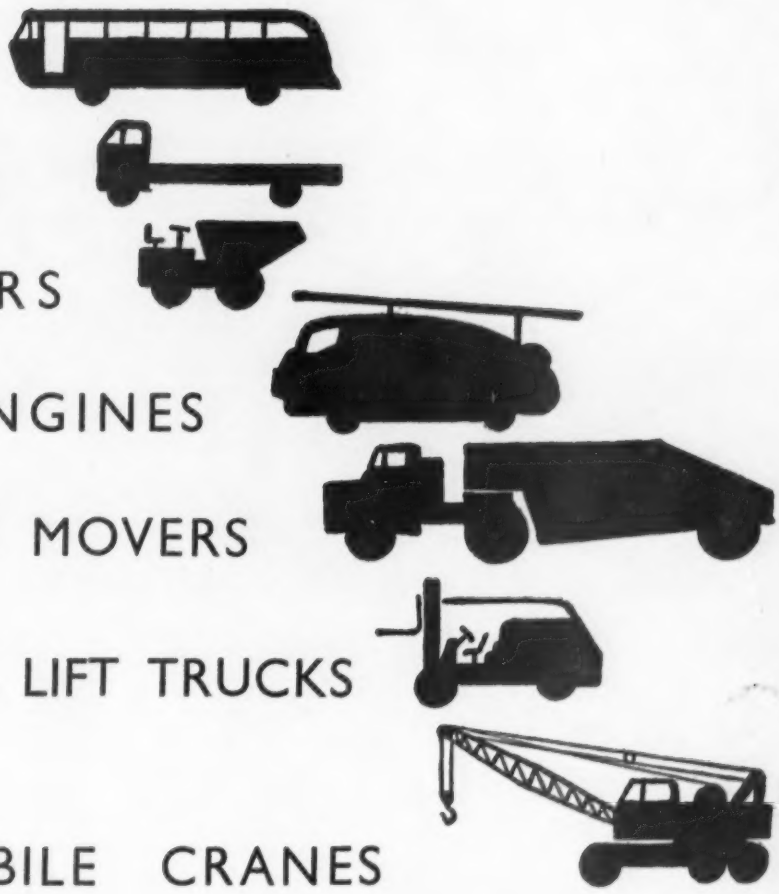

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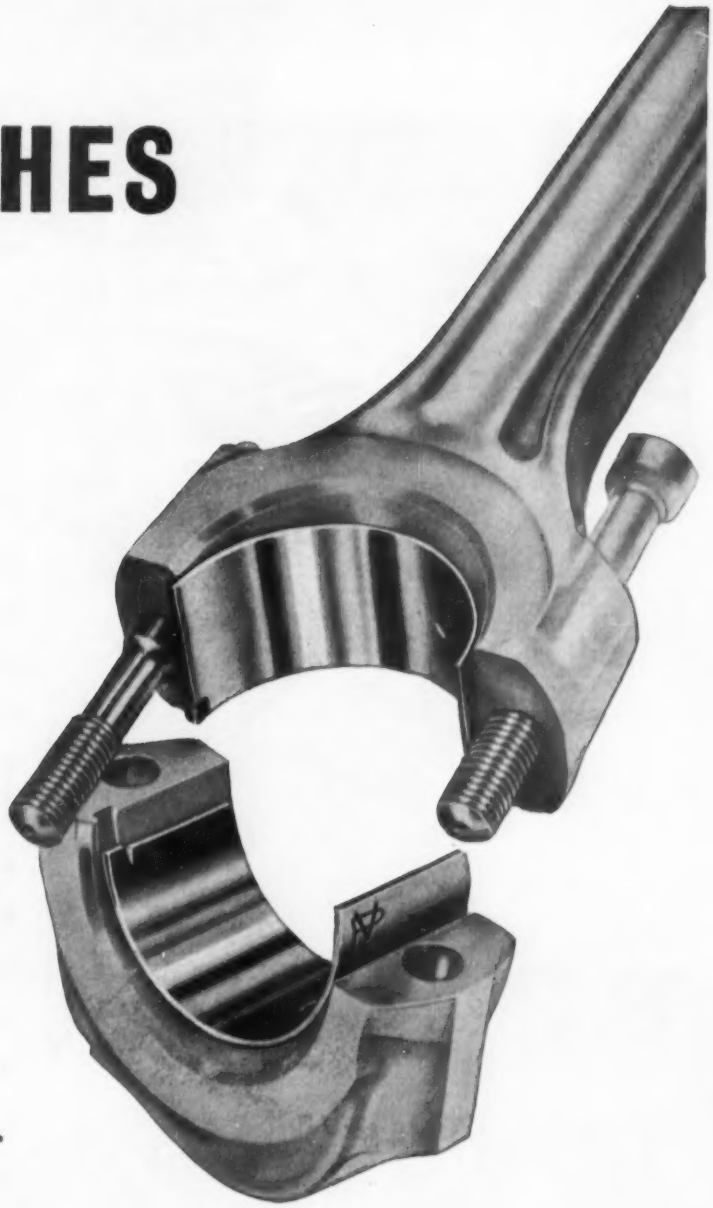

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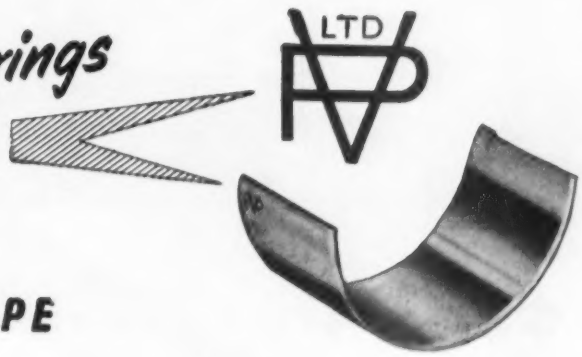

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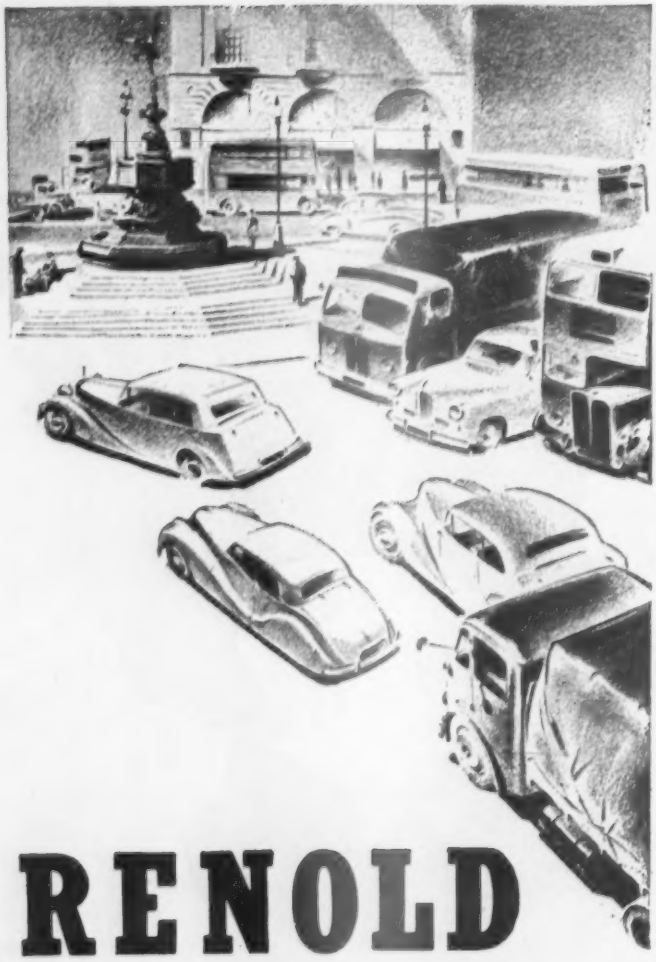

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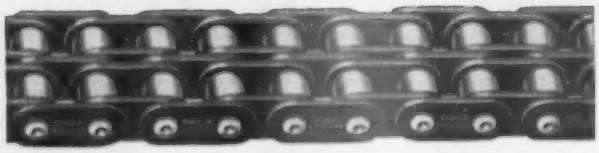

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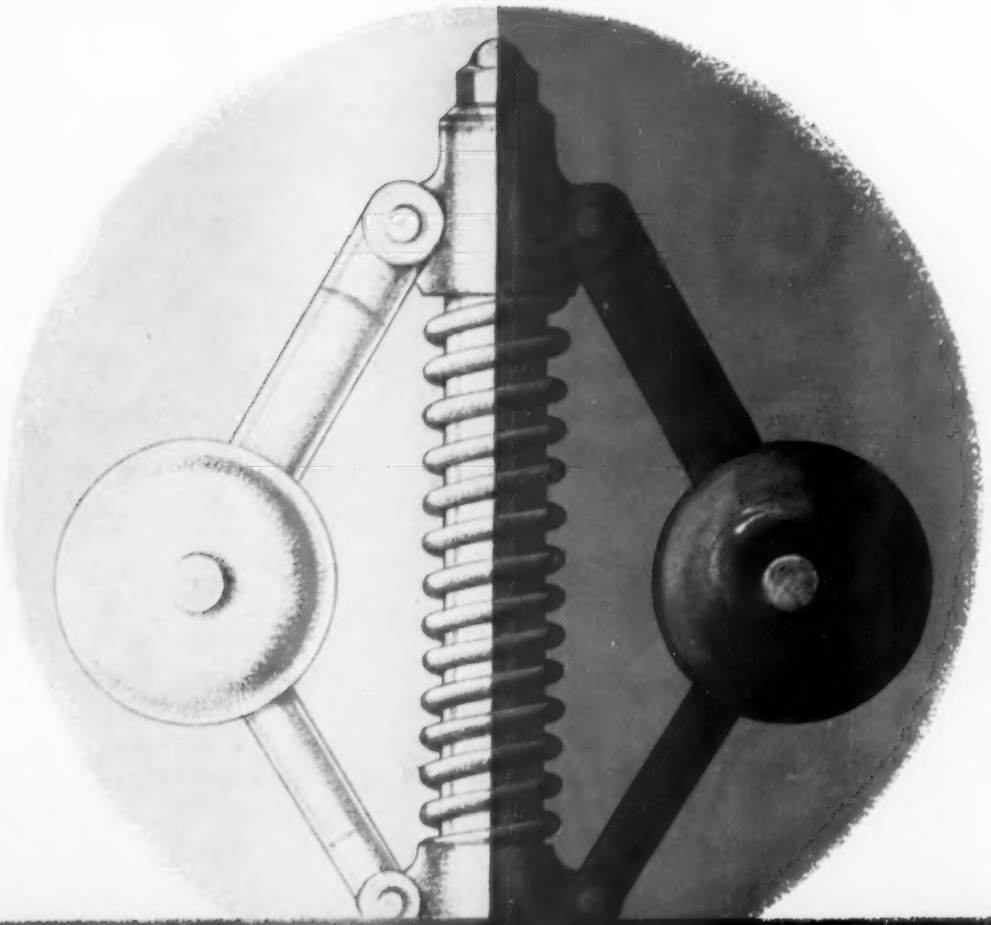

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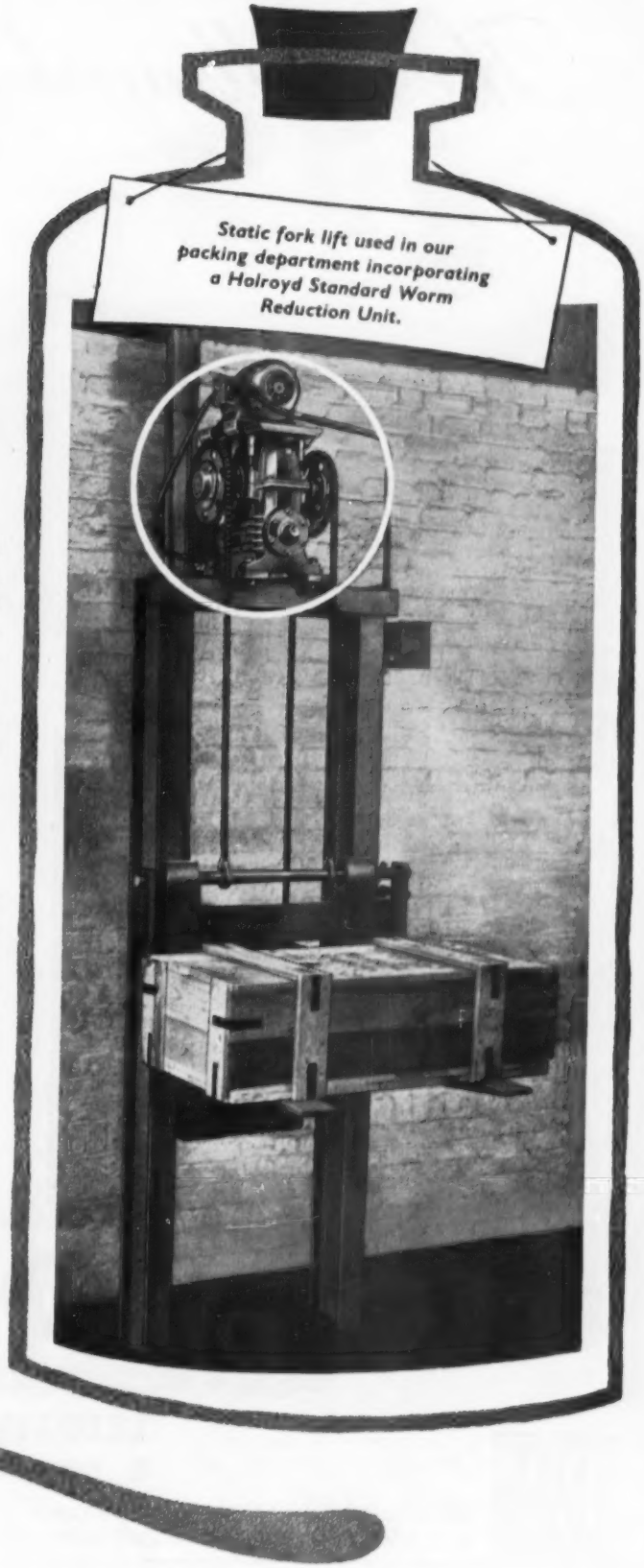

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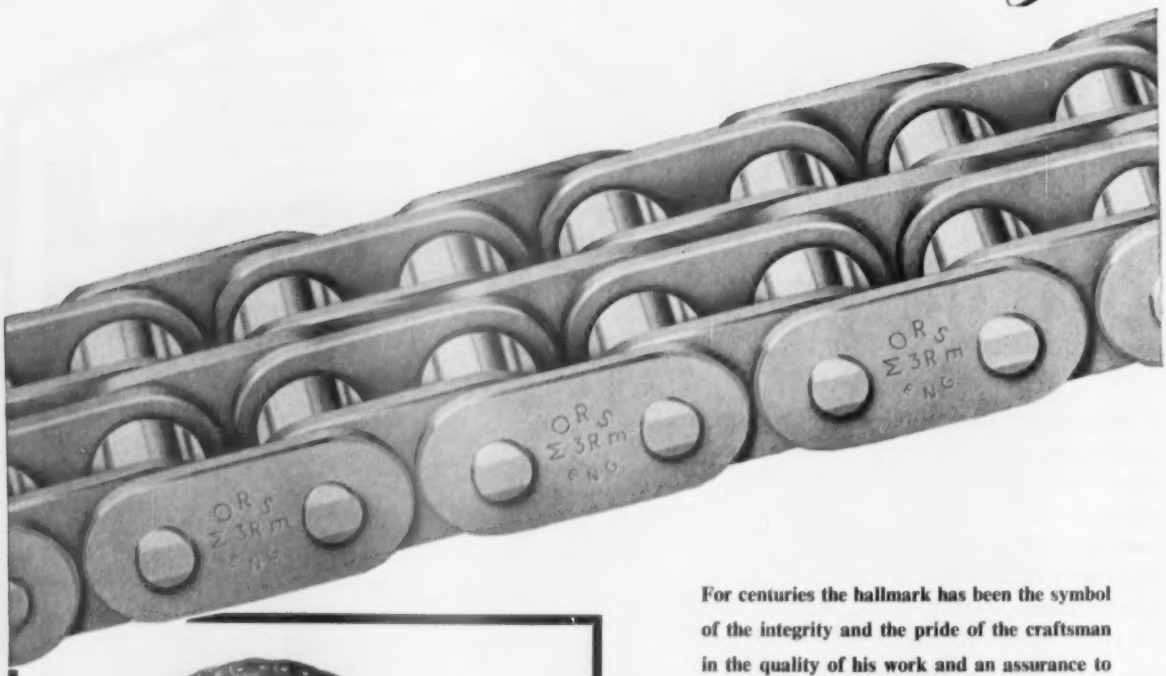

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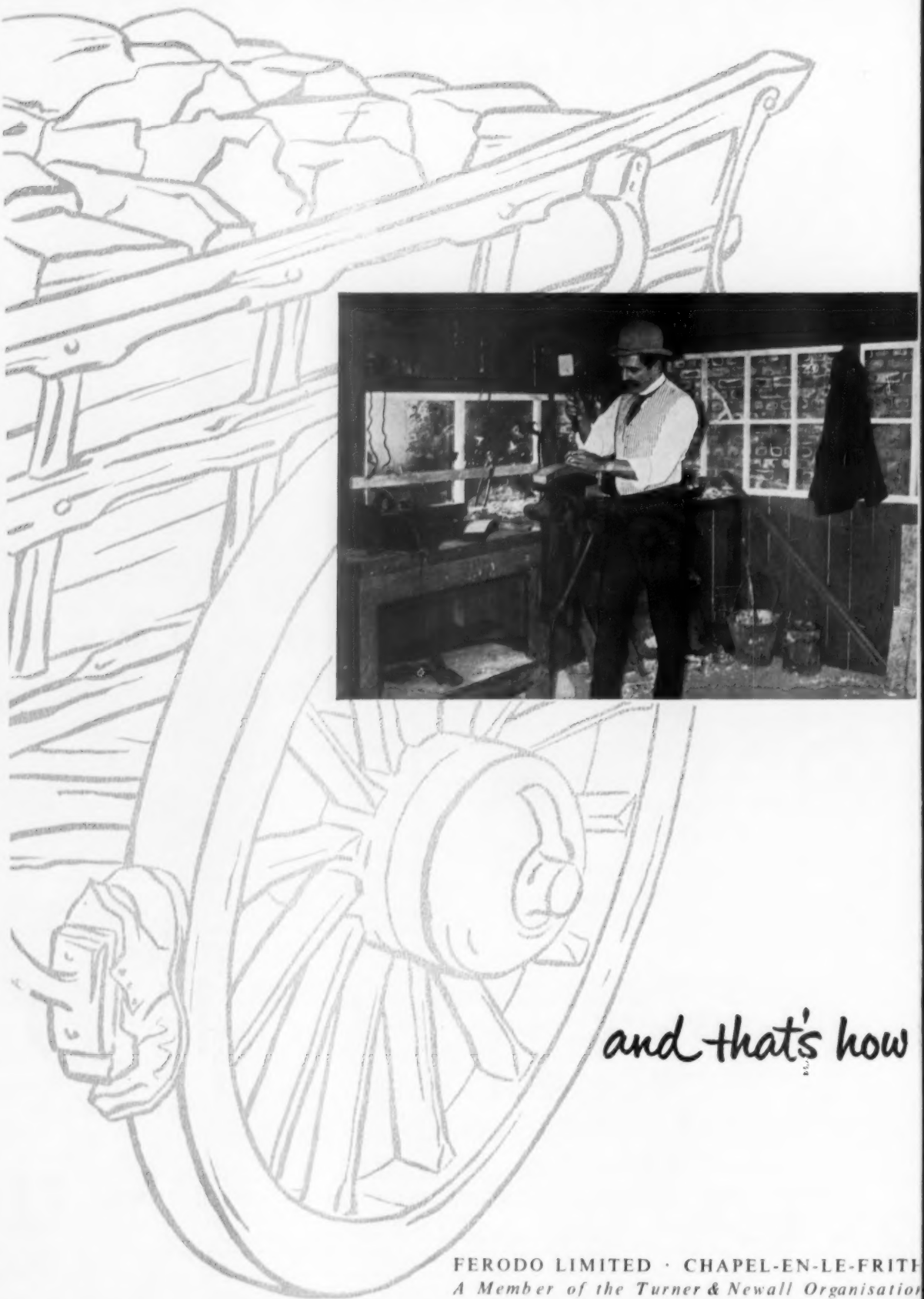

and that's how

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In the long metamorphosis from the small shed in which Herbert Frood founded Ferodo, to the great, uniquely equipped factory of today, some basic characteristics have remained.

Frood had an eager, inquiring mind; after his original inspiration, gained by watching farm carts negotiating the steep hills of his native Peak district, he was always looking for ways to add to the efficiency and safety of the braking materials he developed.

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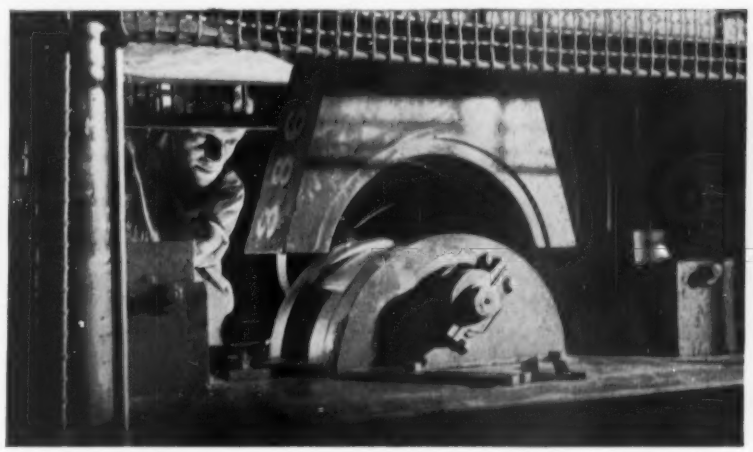

Herbert Frood would have wished it to be

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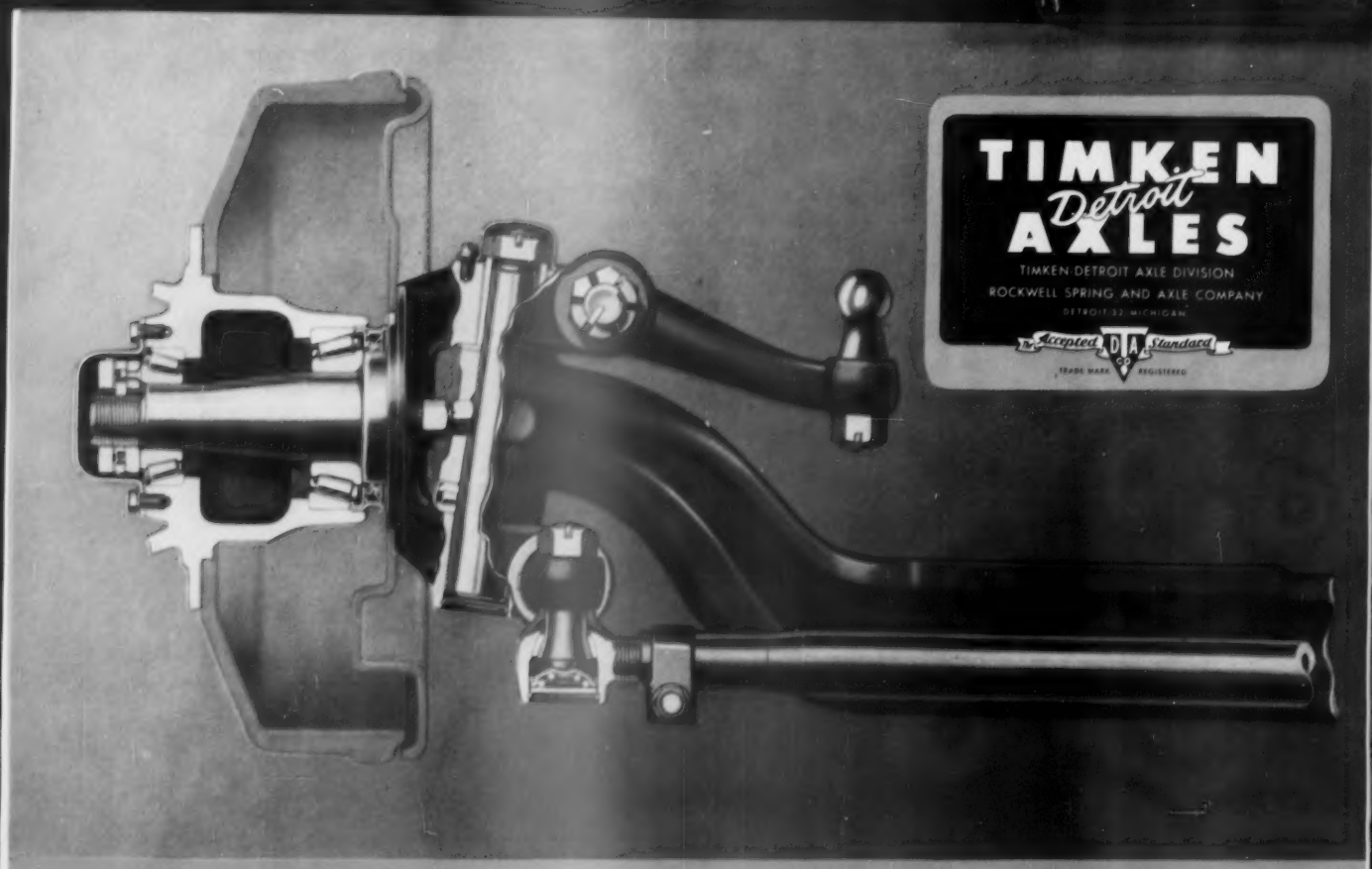

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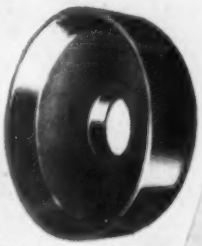

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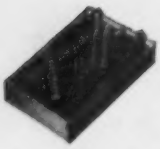

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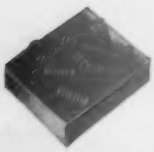

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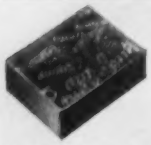

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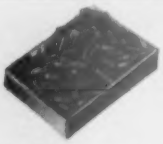

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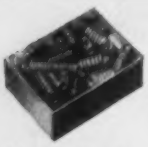

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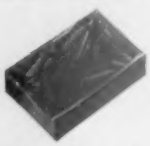

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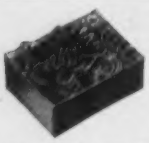

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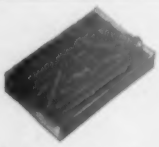

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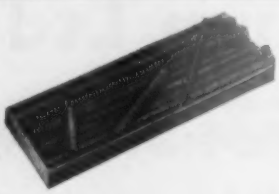

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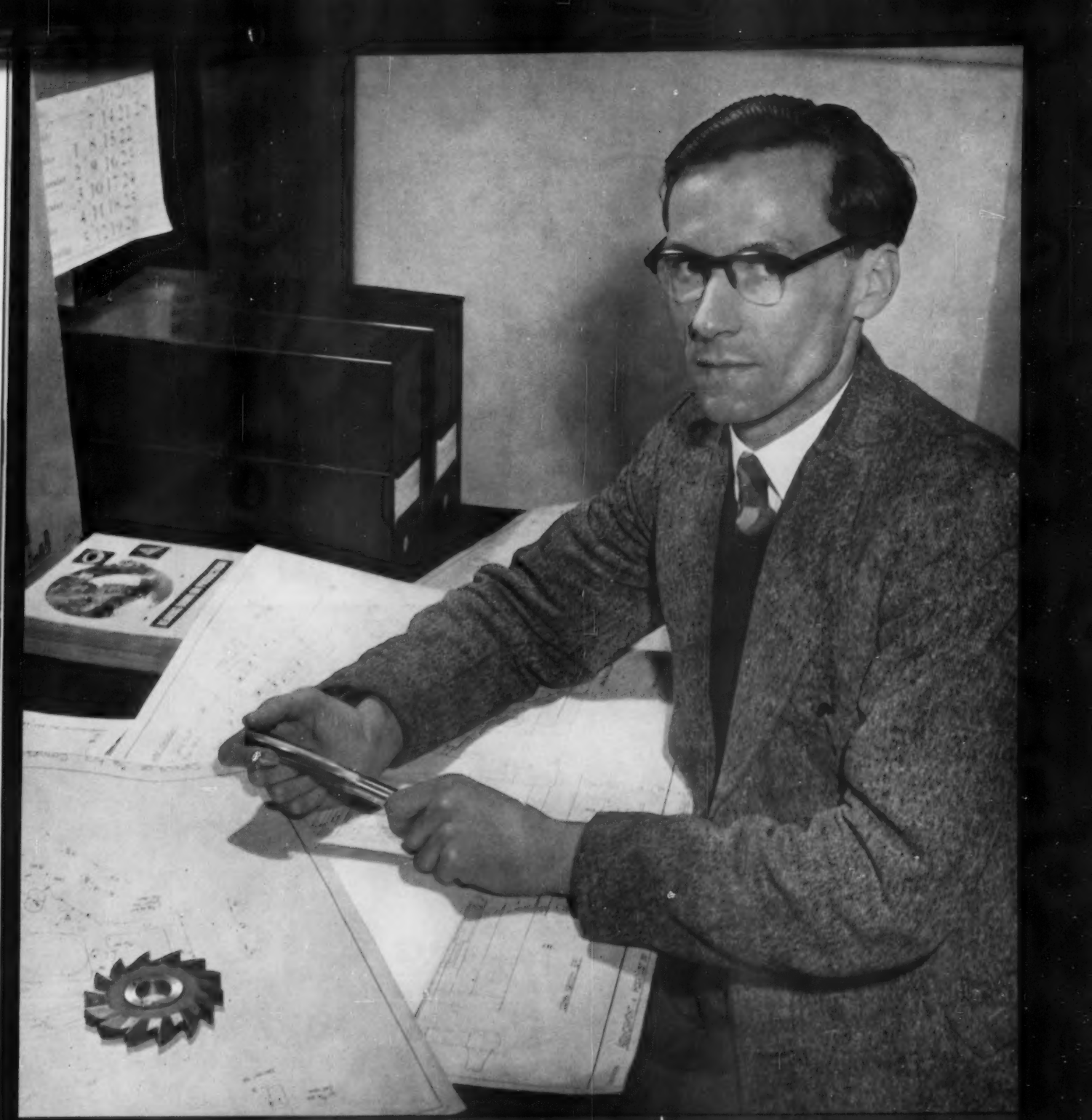

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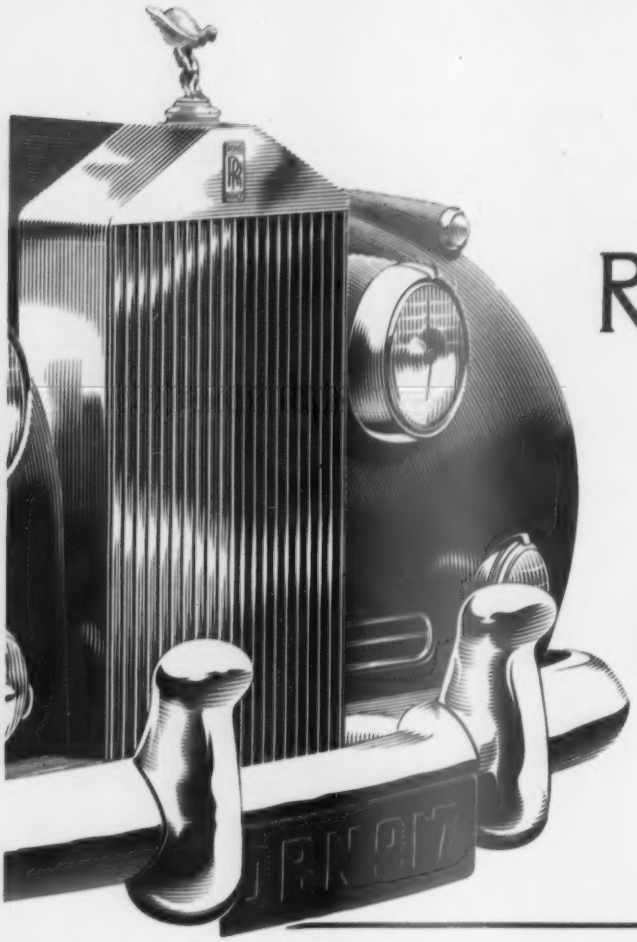

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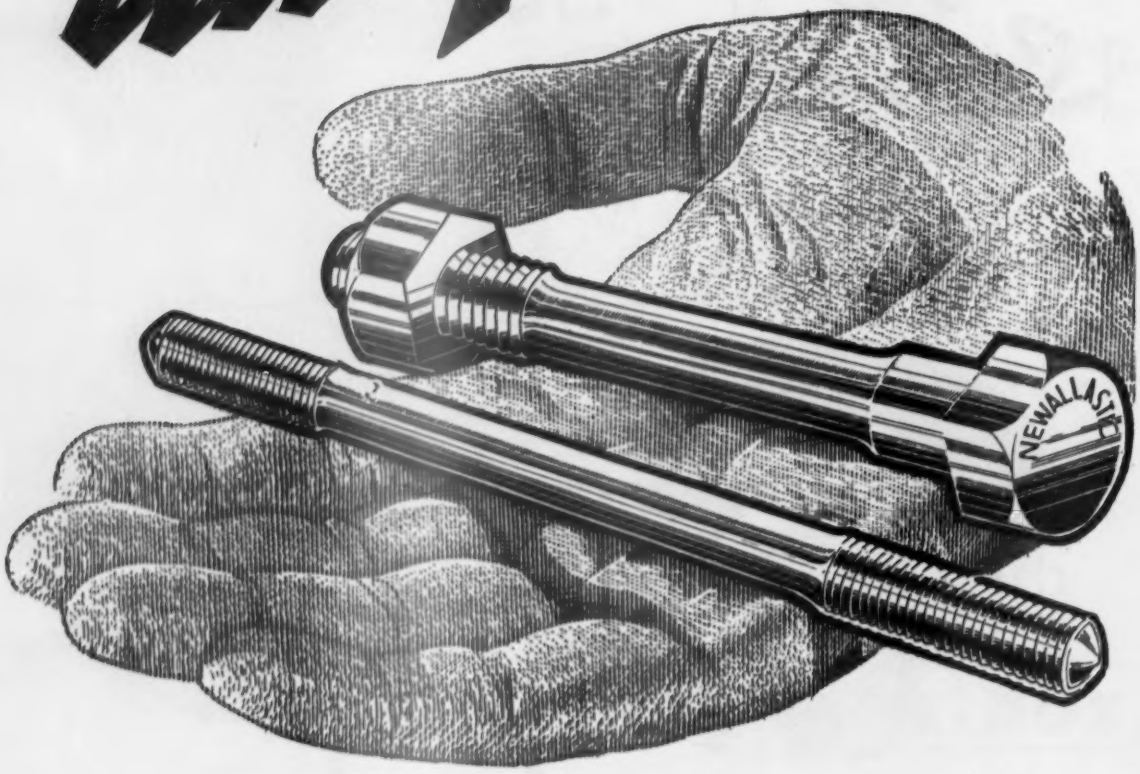

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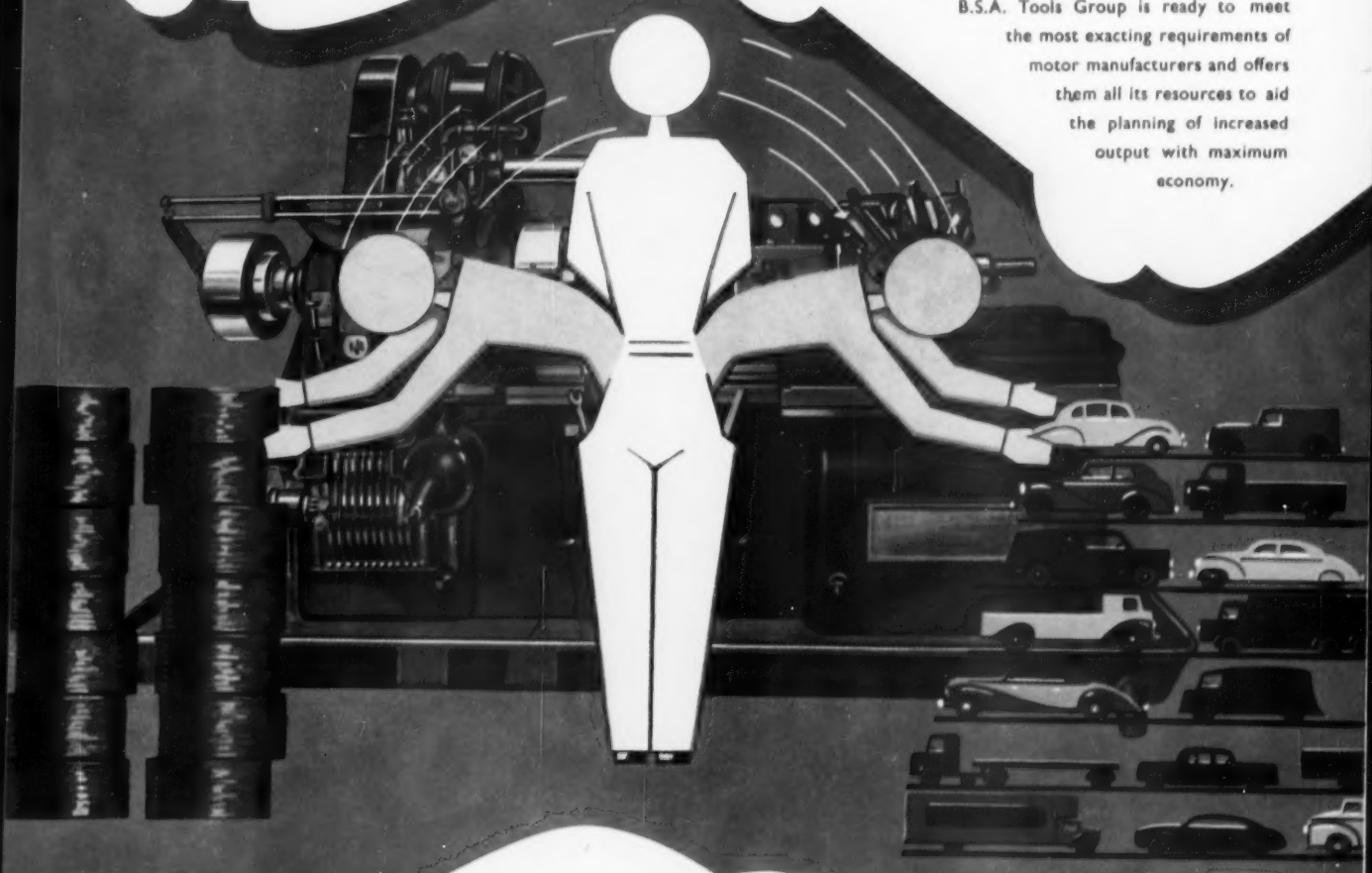

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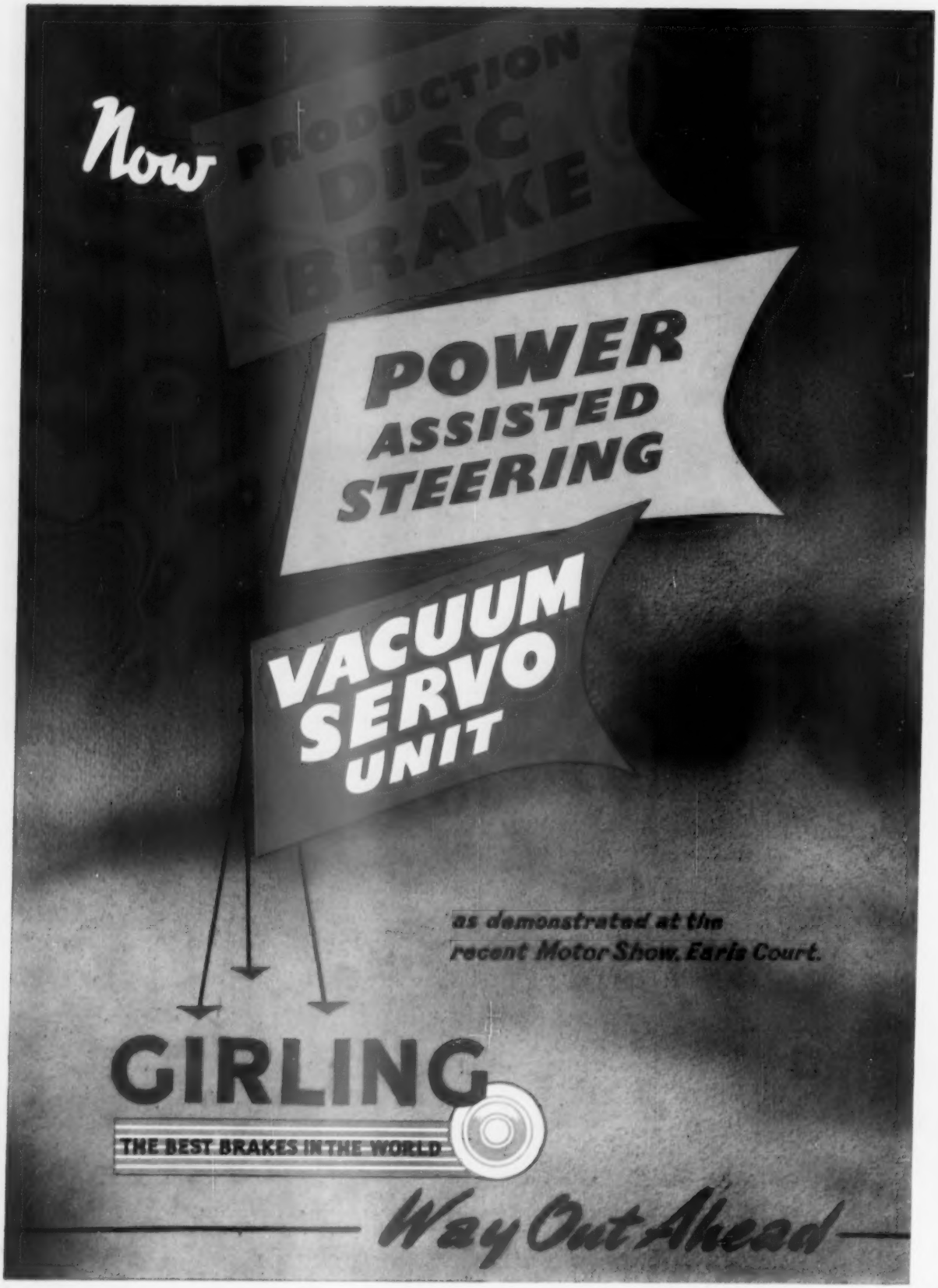

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"Faith!" cried the cavalier — "here is a waggish situation indeed. Meseems I made a splendid landing on thy broad and faithful back. And where didst *thou* come to earth, old friend?"

The Squire squirmed uneasily. "Verily I could not swear to it, but if I mistake me not, we are in the cattleyard." His movements were accompanied by an odd squelching sound. "Verily thou wert unfortunate," said Sir Percy with soldierly sympathy — "perhaps that will teach thee the folly of a spring in the dark. And speaking of springs" — he spake with a knowledge surprising in one of that period — "Didst know that the most inferior springs may look exactly like a genuine high precision job, guaranteed for years of high performance? What! not interested in springs? Ah, well, perhaps a tub would suit thee better." He ambled off into the darkness . . .

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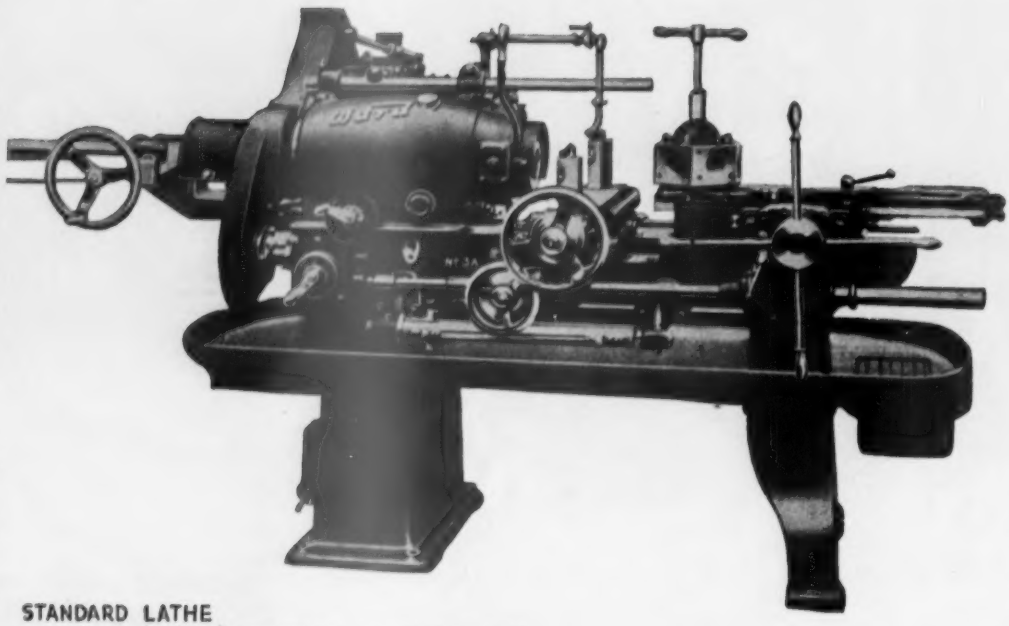

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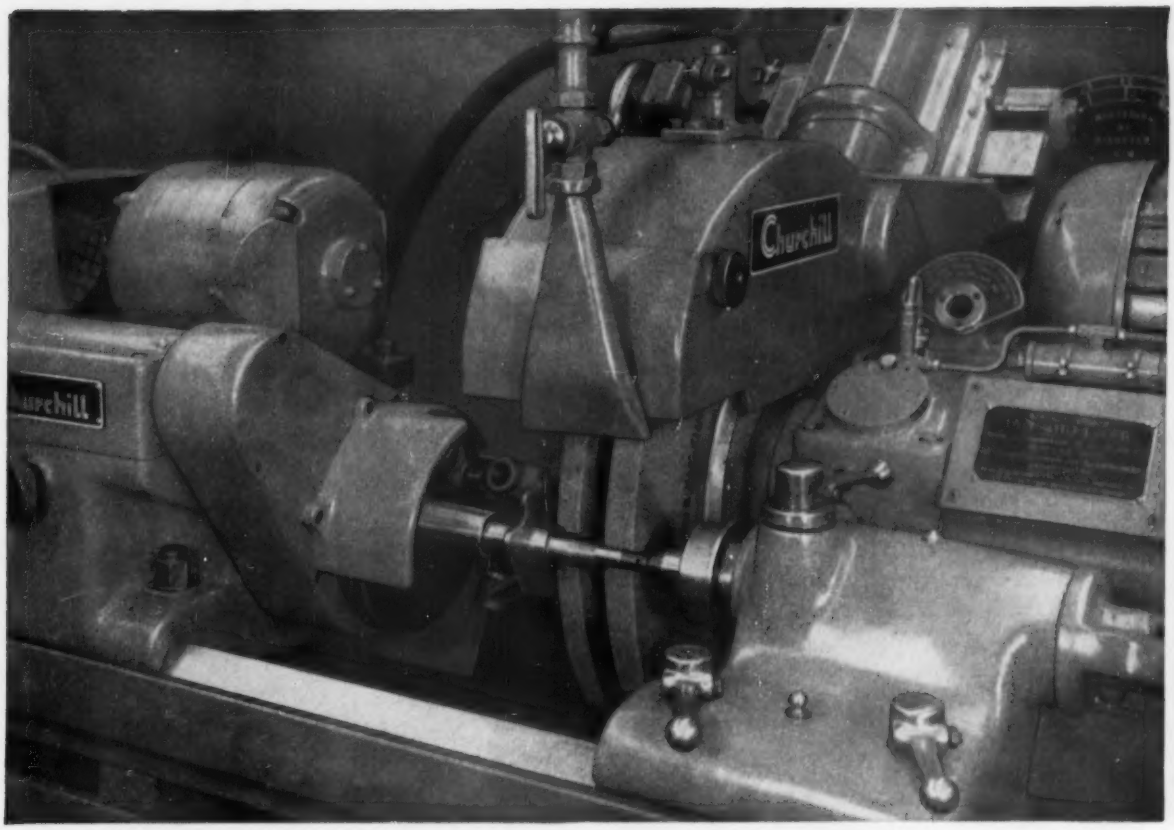

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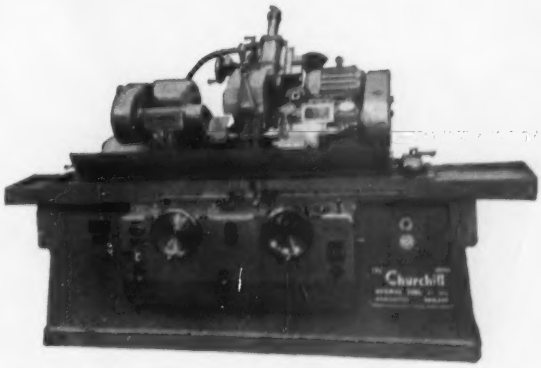

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The Motor Show

WORDS spoken a short time ago by Lord Tedder, Chairman of the Standard Motor Co. Ltd., with reference to his own company's product—"We progress by evolution, not revolution"—could well be applied to all the British exhibits at the 1955 International Motor Show. They could equally well be applied to most of the foreign exhibits. In other words, during the past year the emphasis has been on detail developments along tried and proven lines. Only one new model showed a radical departure from conventional practice.

There are, of course, good reasons for this. In the first place, designs based on accepted practice generally function remarkably well; at worst they give reasonable satisfaction. This being so, there is an understandable reluctance to break away from proven practice and introduce some revolutionary concept. Here it may be said that the very success of the British automobile industry in export markets has tended to discourage design innovations. No matter how thorough the prototype testing, some difficulties are likely to be experienced when the vehicles pass into private ownership and use. If it were possible to restrict sales to the home market for a proving period, any servicing problems that might occur could be dealt with relatively easily, but the position is very different when a high proportion of new production goes overseas.

Furthermore, the lines along which production techniques are developing do not encourage radical changes in design; rather they discourage them. So far as the British industry is concerned, it can be said that the selling prices for 95 per cent of the output of private cars have been kept down to the present levels only because manufacturing costs have been kept low through the employment of special techniques that give very high output. However, these techniques entail very heavy capital expenditure for special machines, which can be offset only by large total output.

An interesting design

The exhibit that definitely departed from proven practice was the Citroën DS19. Its future will be studied with great interest by all automobile engineers, since this development may betoken a very much wider use of hydraulics than has hitherto been customary. The main point of interest in the design is that it incorporates a complicated hydraulic system with several circuits controlled from a master pressure pump and accumulator. One circuit is used for the independent four-wheel oleo-pneumatic suspension. Other circuits supply hydraulic power for the operation of the four-speed gearbox and the clutch, which are controlled by a single change-speed lever on the dash; the clutch pedal is, of course, eliminated. Another circuit operates inboard-mounted disc brakes at the front and normal drum brakes at the rear. There is also hydraulic assistance for the rack and pinion steering. The very complexity of the hydraulic system may possibly create maintenance problems.

Engines

The tendency towards using higher compression ratios in the power units for vehicles that cannot by any stretch of imagination be classed as sports cars has continued. This was to be expected, since with the higher octane fuels now available, the higher compression ratio increases thermodynamic efficiency. Current American practice suggests that compression ratios may continue to rise, but the need to cater for a number of export markets in which the higher octane fuels may not be readily available, if at all, may tend to discourage any further rise in British engines. In fact, several British manufacturers are offering engines with alternative and lower compression ratios, probably for that very reason.

There has also been careful study of breathing characteristics. Improved breathing in conjunction with an increased compression has allowed significant increase in maximum b.h.p. to be obtained by relatively minor modifications to existing engines. It is encouraging that this increase has not been obtained at the expense of the engine characteristics in the lower speed range. On the contrary, in every case it is associated with better performance over the whole range.

Certain British engines showed how design development and production economics can be reconciled. One of these engines is based on a highly successful design that was introduced in 1954 and still continues in production. From the crankcase to the cylinder block joint face, the new engine is identical with the original design, but the cylinder head, the manifolding and the carburettor are different. As the cylinder block, crankshaft, connecting rods, pistons and rings are common to both engines, the manufacturing costs are considerably lower than would be entailed in the production of two completely different engines. Consequently, the vehicles into which these power units are fitted are both offered at attractive selling prices. This is a practice to be commended.

The most significant development in transmissions was

the greatly increased number of cars selling at less than £1,000, including purchase tax, for which overdrive is available, usually as an optional extra. On the Sunbeam Rapier, however, the overdrive is an integral component of the design; another practice to be commended. Whether it would be feasible to fit an overdrive to the low price small car is a matter that calls for some consideration. A fairly common overseas complaint against these cars is that when the engine is driven at high speed for long distances, it gives the impression of being overworked and fussy. An overdrive would, of course, counter this criticism, but exactly what effect the necessary increase in price would have on sales is a matter for market research.

Fully automatic transmission, which is now fitted to most American cars, is still restricted to the more expensive British cars. This was expected. However, both in 1954 and again this year, there were hopes in many quarters that some form of two-pedal control would be available on cars selling at less than £1,000 in all. In the event, it proved that only one manufacturer has done this. Rather remarkably, this applies to one of the cheaper cars, the Renault 750, which can now be fitted with the Ferlec electro-magnetic automatic clutch. The new Armstrong Siddeley Sapphire with Lockheed Manumatic control was the cheapest British car to have two-pedal control.

It is, however, an open secret that considerable development work has been carried out on a proprietary mechanism that will give two-pedal control through automatic clutch operation when used in conjunction with an ordinary gearbox, or fully automatic transmission in conjunction with a special gearbox. This mechanism is much simpler and should be considerably cheaper than the various mechanisms used on American cars.

Suspension

Most manufacturers, even those introducing completely new models, continue to employ suspension systems that differ little, if at all, from those that were shown in 1954. Citroën and Packard were exceptions. Both these manufacturers have devised suspension systems designed to give a constant static height regardless of the load carried. Of these two designs, by far the more interesting is the oleo-pneumatic system used on the Citroën DS19. The principle on which the system is based was proved on the later models of the six-cylinder car which the DS19 replaces. On the earlier model it was applied only to the rear wheels, but the new model has oleo-pneumatic suspension for all four wheels. The Packard system is mechanical. There is a long torsion bar at each side of the frame, running from front to rear. These bars are automatically adjusted for load by means of compensating torsion bars which are controlled by an electric motor.

Brakes

Despite their admitted advantages, disc brakes appear on only one production car, the Citroën DS19. They are used at the front only, and are mounted inboard on the half shafts. Although there is a reluctance to change from the normal drum brake, both Lockheed and Girling have carried out a great deal of development work on disc brakes during the past year, and obviously have confidence in their future.

Meanwhile, the question of improved braking efficiency, particularly for the faster and heavier cars, has been carefully studied by both the makers of friction materials and the manufacturers of brakes. In great part, the problem is, of course, one of significantly reducing brake fade. The makers of friction linings showed new materials with improved fade resistance; the brake manufacturers are seeking improvement by departing from the high-shoe factor, two-leading shoe design.

Vacuum servo assisted brakes are much more common, and both Lockheed and Girling have developed interesting new systems which require a certain degree of vacuum servo assistance. The Lockheed Brakemaster, which is fitted to the new 2·4 litre Jaguar, shows a reversion to the fixed abutment leading and trailing shoe brake for the front wheels. Girling continue to use their two trailing shoe brake in conjunction with a vacuum servo unit of their own design.

Power Steering

There is as yet no urgent demand for power-assisted steering on British cars, but apparently a demand is expected, since four accessory manufacturers displayed power-assisted systems. Apart from the American exhibits, the only cars to have power-assisted steering were the Armstrong Siddeley Sapphire 346 and the Citroën DS19. The Sapphire incorporates the Girling system, while the Citroën system is factory designed. There are considerable differences between the two systems. The Girling system allows the degree of assistance to be varied instantly by the driver from zero to almost 100 per cent; the Citroën gives power steering rather than power-assisted steering. The flexibility of the Girling system in this respect appears to be the more satisfactory.

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EARLS COURT EXHIBITION

A Review of Design Trends

ENGINES

Higher Thermal and Volumetric Efficiencies. The Policy of Rationalization Extending

IN reviewing the basic design of the engines that were making their début at Earls Court a year ago, certain trends were noted. A critical examination of the engines appearing for the first time this year showed that the same trends were again in evidence. This is, of course, to be expected, because basic design has gradually evolved over a period of years, and it has, moreover, been proved by the passage of time to be fundamentally sound in character. In fact, revolutionary features of design are no longer to be looked for. This does not mean that the process of evolution is now complete, or that progress may no longer be expected, but it does imply that the rate of future progress may be slow.

Adherence to what has come to be considered conventional practice in engine design is also encouraged by the policy of rationalization. While this originated within the large manufacturing groups, such as B.M.C. and Rootes, it has also extended to the individual manufacturers, such as Jaguar, Armstrong Siddeley and Singer. The British Motor Corporation continues to make extensive use of its basic engines in its Austin, Morris, M.G., and Wolseley ranges, with only minor changes in specifications such as the number and type of carburettors. Likewise, the Rootes Group continues to install the 2¼ litre engine in both the Humber Hawk and the Sunbeam Mk III, and now utilizes a modified form of the 1·4 litre, overhead valve engine, introduced a year ago for the Hillman Minx, for the new Sunbeam Rapier.

At the same time, from the basic design point of view the engine of the new 2·4 litre Jaguar may be considered as a short-stroke version of the 3½ litre power unit. By the same standard, the Armstrong Siddeley model 234 can be described as a four-cylinder variant of the six-cylinder 3·4 litre Sapphire, and the Singer Hunter 75 is a double overhead camshaft version of the original single overhead camshaft design.

Rootes

The trend towards higher thermal efficiency and higher specific power outputs is well exemplified by comparing the Sunbeam Rapier and the Hunter 75 engines with the original versions from which they have been evolved. To deal first with the 1·4 litre Hillman engine and its Rapier variant, the four cylinders have a bore and stroke of 3 in, so that the engines are truly "square." The combustion chambers are of the off-set, bath-tub type with a considerable quench area; the valves are set vertically in line, the valve gear being of normal design. Each valve is in an individual port, and ample water jacketing is provided round all ports. To ensure cooling of the exhaust valves, thimbles are inserted in the cylinder head to direct a flow of water round the valve seats. The jackets around the cylinder barrels also extend the full length of the bores.

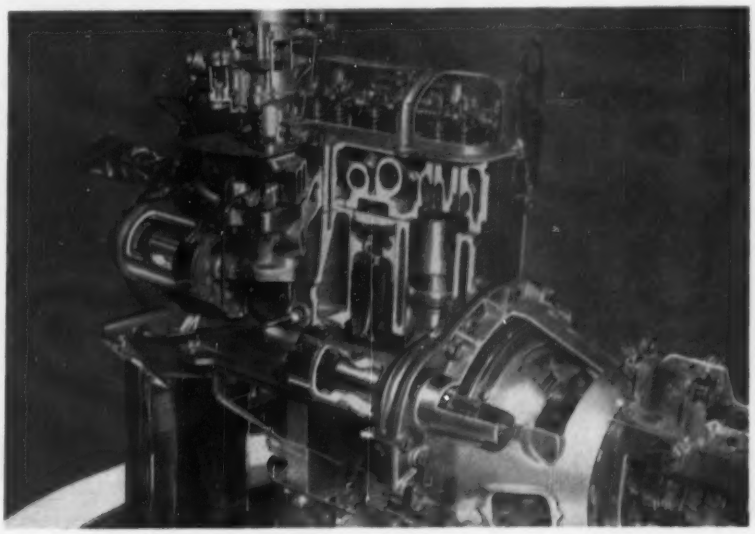
With a compression ratio of 7:1, the Hillman engine gives a maximum output of 43 b.h.p. net, 47 b.h.p. gross, at 4,400 r.p.m. The maximum torque and b.m.e.p. are 66·3 lb-ft and 118 lb/in² respectively at 2,200 r.p.m. Thus, the specific power output is 31·0 b.h.p/litre and the piston loading 1·52 b.h.p/in².

In the Rapier version the compression ratio is increased to 8:1, and better breathing is provided by new inlet and exhaust manifolds, with a larger downdraught Stromberg 36DIF carburettor. As a result of the improved volumetric and thermal efficiency, the maximum power is increased to 62 b.h.p. gross at 5,000 r.p.m., a gain of 32 per cent. The maximum torque and b.m.e.p. are 73·2 lb-ft and 130 lb/in² respectively at 3,000 r.p.m. Accordingly, the specific power output is appreciably higher, 44 b.h.p/litre. In view of the higher peak speed, slight modifications to the valve gear have been made. The push rods are tubular with ball ends; thus, their weight is reduced and their strength increased. The same valve springs are used, but with a lighter seating load, and the range of operating stress is approximately the same.

Singer

The Singer Hunter 75 engine is developed from the Singer standard, four-cylinder, 1,496 cm³ unit, which for many years has had a single overhead camshaft operating slightly inclined valves through rocker gear. In its latest form it has a twin overhead camshaft head with hemispherical combustion chambers. This head bolts directly on the cylinder block, which below the gasket is unaltered in design, although the cast iron crankshaft is replaced by a forged shaft of En 16 steel.

A cast iron head is employed and the combustion chambers are truly hemispherical in that the centre of the sphere is at the level of the joint face. The chambers are machined all over, and the valves are set at an included angle of 90 deg, equally spaced on each side of the cylinder axis. Bolted to the valve chest on each side is a separate cast iron tappet block, the top face of which is split on the centre-line of the camshaft. The lower halves of the

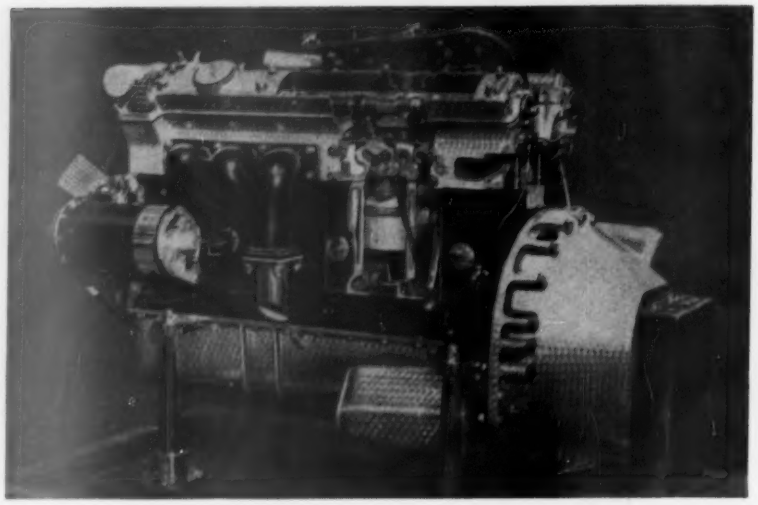


The Sunbeam Rapier engine has ample water jacketing round the valve ports, and the cylinder jackets extend the full length swept by the compression rings

three camshaft bearings are formed in this tappet block and cast iron bearing caps are used. Thus, the camshaft runs direct in the cast iron block without separate bearing shells. The centre bearing cap is 2¼ in wide and is secured by four studs; oil is fed to it under pressure and passes through a drilling down the centre of the shaft to the two end bearings.

The valve gear is of the direct acting type which eliminates thrust between the valves and guides. Hardened steel, shouldered tappets are interposed between the camshaft and valve stems, and the correct valve clearance is obtained by selecting suitable tappets from a range of graded lengths. A flat on the smaller diameter of the tappet acts as an oil drain to prevent hydraulic lock. The camshaft runs in a bath of oil, and any oil draining from the camshaft chamber to the spring chest passes through drain holes arranged so that the level cannot rise to the top of the valve guides.

Vertical inlet ports are arranged on the inside of the head. Ports one and two, and three and four, converge into two separate ports, to each of which a Solex 32 PBI downdraught carburettor is bolted. The inlet manifold is water jacketed and incorporates the thermostat and water outlet to the radiator. Water is circulated from the pump at the front of the engine through a light alloy manifold, which leads it to the cylinder head at four points adjacent to the exhaust valves. At each of these points a calibrated tube discharges the water directly on to the exhaust valve guides, by way of holes drilled through the boss of the head into which the guide is pressed. The water then flows across the jacket above the combustion chamber and round the sparking plug bosses to the inlet valve side, and so to the jacket of the inlet manifold. Water passages between the head and the cylinder block provide for cooling of the cylinder bores by thermosyphon action.



In this partly-sectioned exhibit of the new 2·4 litre Jaguar engine, the arrangement of the direct-acting valve gear can be seen

A two-stage drive by two-strand chains is used for the camshafts. The first stage is a short one, from the crankshaft sprocket to a sprocket on a jack shaft set low down in the crankcase. From this shaft the oil pump, distributor, and fuel pump drives are taken. The second stage chain passes over the second sprocket on the jack shaft, and a spring-loaded jockey sprocket, to the inlet camshaft sprocket. Thence, it is passed over an idler sprocket with an eccentric spindle, to the exhaust camshaft sprocket, and over a fixed idler. The spring-loaded jockey sprocket provides tension on the slack side of the chain, and automatically compensates for chain wear. The two idlers are necessary to obtain the required arc of contact on the camshaft sprockets. Between the idler and the jack shaft sprockets on the tight side of the chain, there is a damper to deal with chain thrash. The idler sprocket with an eccentric spindle is for the initial setting of the timing between the two camshafts.

With the standard, single camshaft engine, a 7·2:1 compression ratio is used, and the power output is 50 b.h.p. at 4,300 r.p.m. The maximum b.m.e.p. is 134 lb/in² at 2,000 r.p.m. For the Hunter 75, a compression ratio of 8:1

The camshafts of the Singer Hunter 75 engine run directly in the cast iron tappet blocks and are oil-bath lubricated. The oil is fed into the centre bearing and thence through holes in the shafts to the end bearings

Although twin camshafts are employed on the 2½ litre Riley Pathfinder, they are carried high up in the crankcase and actuate the valves in the hemispherical heads through push rods and rockers

has been adopted, the pistons having slightly domed crowns to give this figure. The output is increased to 75 b.h.p., developed at 5,250 r.p.m., and maximum b.m.e.p. is 140 lb/in² at 3,000 r.p.m. This, however, has been obtained without sacrificing the performance at the lower end, the b.m.e.p. being 121 lb/in² at 1,000 r.p.m., against 108 lb/in² for the standard engine.

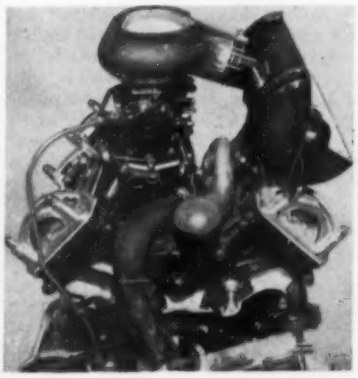
As the bore and stroke are 2·88 in and 3·5 in (73 mm and 89·4 mm) respectively, the stroke:bore ratio is 1·22:1. At peak speed of 5,250 r.p.m., the mean piston speed is, therefore, 3,080 ft/min, appreciably above the figure of 2,500 ft/min which has come to be regarded as the optimum for the normal car. It was observed a year ago in reviewing engine design that the average value for six new engines was 2,465 ft/min. In the case of the Hillman Minx engine with a stroke:bore ratio of 1:1, having a peak speed of 4,400 r.p.m., the mean piston speed is only 2,200 ft/min, and when the peak speed is raised to 5,000 r.p.m., as in the case of the Rapier engine developed from it, the figure rises to 2,500 ft/min.

Jaguar and Armstrong Siddeley

Both the 2·4 litre Jaguar and the 2·3 litre Armstrong Siddeley Sapphire, model 234, are of particular interest because they represent another phase of development by methods differing from those represented by the Rapier and Hunter 75 engines. Thus, the Jaguar is a short stroke variant of the 3½ litre XK power unit, while the Sapphire 234 is a four-cylinder variant of the six-cylinder Sapphire, having the same bore and stroke. Both these new engines, therefore, have the same combustion chamber characteristics and valve gear as the original designs of which they are developments.

The new Jaguar engine has a stroke of 76·5 mm (3·0118 in), and the same bore as the larger engine, that is, 83 mm (3·2677 in). This gives a swept volume of 2,483 cm³ (151·5 in³) for this 2·4 litre, six-cylinder unit. The piston area of 50·4 in² is, of course, the same as that of the XK engine. So, also, is the rating, by the R.A.C. formula, of 25·6 h.p., which, of course, serves to emphasize how out-of-date the formula rating is. With a compression ratio of 8:1, the maximum output is 112 b.h.p. at 5,750 r.p.m. and the b.h.p/in² piston area is 2·22. The maximum b.m.e.p. is 140 lb/in² at 2,000 r.p.m. At peak output speed, the mean piston speed is 2,880 ft/min, which again reflects the advantage of a low stroke-bore ratio, in this case 0·92:1.

The cylinder head, of high tensile aluminium alloy, is interchangeable with that of the 3½ litre unit, as also are a number of other components. The combustion chambers are hemispherical and the valves, served by twin overhead camshafts, are at an included angle of 70 deg. The adoption of the shorter stroke has allowed the height of the chrome iron cylinder block to be reduced and has effected



A light alloy water rail delivers coolant over the exhaust valve ports of the Singer Hunter 75

an appreciable saving in weight. The connecting rods are also shorter, but for the sake of interchangeability the bearing sizes are the same as those of the XK engine. As these are of generous size for the original engine, they provide a very high factor of safety for the 2·4 litre unit.

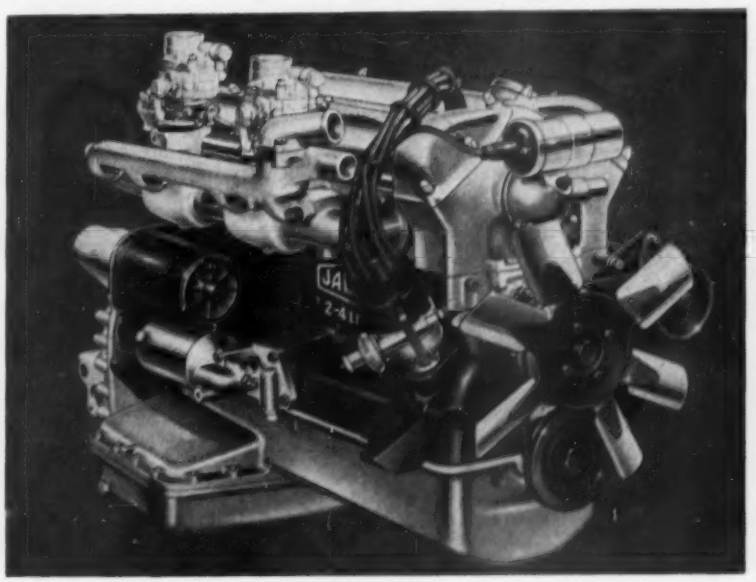
The Jaguar XK engine, of course, has been progressively developed over a long period, and the type D, with a 9:1 compression ratio, has an output of 250 b.h.p. at 6,000 r.p.m. The maximum torque is 242 lb-ft, and the maximum b.m.e.p. is 174 lb/in² at 4,000 r.p.m. The specific power is, therefore, 73 b.h.p/litre with a piston loading of 4·95 b.h.p/in².

In the case of the Sapphire 234, the combined crankcase and cylinder block is of cast iron, as is the cylinder head also. The three main bearings of the crankshaft are of large size, the diameter being 2·75 in, and the length 1·25 in for the front and centre, and 1·625 in for the rear. Steel-backed, white metal bearing shells are employed. The connecting rods are H-section forgings, and their big ends are split diagonally. Each big end bearing is 2·125 diameter by 1·125 in long.

As a result of development work carried out during the past year, the connecting rods have been made stiffer and the floating gudgeon pins stronger than in the six-cylinder engine. The light alloy pistons with domed tops have two compression rings, the top ring being chromium plated, and one oil control ring. Both the bore and stroke are 90 mm and the swept volume is 2,290 cm³. With a compression ratio of 7·5:1, the engine develops a maximum of 120 b.h.p. at 5,000 r.p.m., and the maximum b.m.e.p. is 150 lb/in² at 3,500 r.p.m. The piston area is 39·44 in², so the piston loading is 3·04 b.h.p/in². At peak power, the piston speed is 2,950 ft/min.

As in the original engine, the camshaft is carried in three bearings high up on the right-hand side of the cylinder block, and the valves in the hemispherical combustion chambers are operated by inclined push rods and rockers. The combustion chambers are fully machined. To withstand the stresses of high speed operation, the rockers have been made stiffer than in the original design. The diameter of the inlet valves is 1·80 in, and of the exhaust valves 1·59 in, an increase of 0·1 in over those of the six-cylinder engine. Separate rocker shafts are used for the inlet and exhaust valves; each is carried in five pedestals against which the rockers are held by light coil springs.

The inlet ports are siamesed, and the two S.U. HD6 carburettors are



The 2·4 litre Jaguar engine is a short-stroke development of the famous 3½ litre XK unit. The cylinder head is common to both models

mounted at an angle of 30 deg, one on each of the two light alloy water jacketed manifolds. A large-diameter balance pipe connects the manifolds. The carburettor air intakes are enclosed in a box from which a central pipe runs across the head to a large air cleaner.

Twin exhaust manifolds on the left-hand side of the engine couple ports one and four, and two and three. The two exhaust pipes then merge and enter a common silencer. A gallery tube along the left-hand side of the block conducts water from the pump at the front of the head to the region of the exhaust valve guides. The water leaves the head at the front, and passes through a thermostat back to the radiator. A by-pass conducts water to the induction manifold jackets. To reduce the overall height of the engine, the fan is not mounted on the pump spindle, as is the case on the six-cylinder unit; instead, it is driven by a separate belt from a second pulley on the front end of the crankshaft.

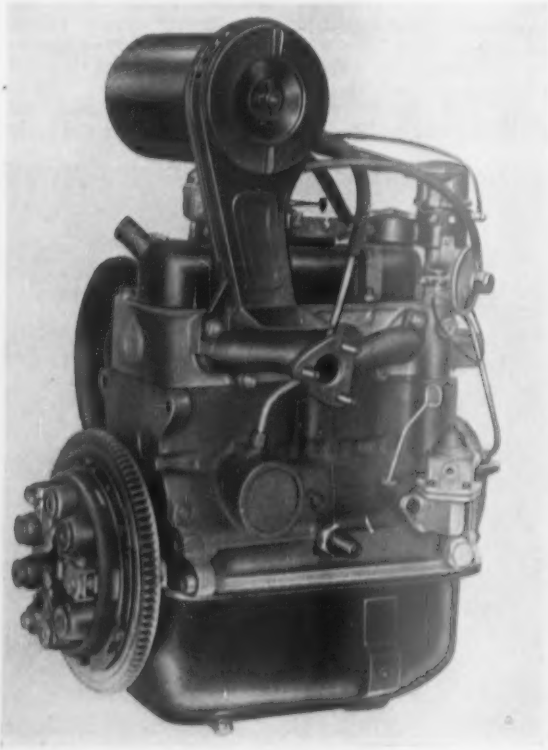
Fiat

Although the four-cylinder Fiat 600 engine was fully described in the October, 1955, issue of *Automobile Engineer*, this survey of recent developments would not be complete without a recapitulation of the main features of interest. This power unit is an addition to the lengthening list of engines of the square or over-square type. It has a bore of 60 mm and a stroke of 56 mm, the swept volume being 633 cm^3 and the stroke:bore ratio 0·933:1. With a compression ratio of 7:1, its maximum gross output of 21·2 b.h.p. is developed at 4,600 r.p.m., when the mean piston speed is 1,690 ft/min. Maximum b.m.e.p. of 113·7 lb/in^2 and maximum torque of 28·9 lb-ft are obtained at 2,800 r.p.m. Other specific performances are: a piston loading of 1·21 b.h.p/in^2 and a power output of 33·6 b.h.p/litre.

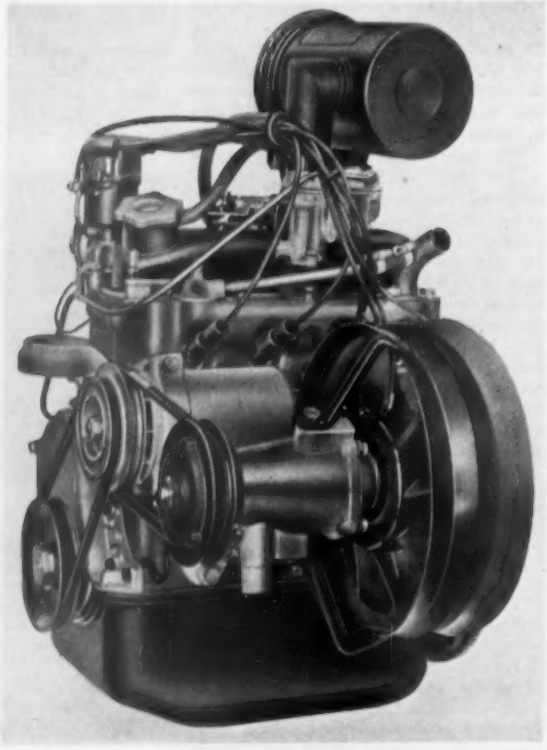
Compactness and lightness are features of the design. For compactness, the first and second cylinders, also the third and fourth, are siamesed; to reduce weight, the cylinder head is of light alloy. The cylinder block and crankcase are of grey cast iron. A three-bearing crankshaft is employed. It is a steel forging, with main journals of 1·996-2·00039 in diameter and crankpins of 1·3775-1·3783 in diameter. The front and rear main bearings are Vandervell D2 bimetal; although a similar top half is used in the centre bearing, the lower half is a Trione copper-lead lined, steel-backed shell. This unusual arrangement is adopted in view of the relatively heavy loading due to the fact that the shaft is unbalanced. Vandervell D2 thrust washers, carried in a counterbore in each end of the centre bearing housing and cap, provide for axial location of the shaft.

Connecting rods of H-section are employed. They are offset 2½ mm from the centre of the big end bearing towards the adjacent main bearing, this being necessitated because of the close spacing of the pairs of cylinders. The big end caps are split at 90 deg, but, nevertheless, can be withdrawn through the cylinders because of the comparatively large diameter of the bores. The big end bearings are copper-lead lined steel shells. Wrapped bronze bushes are fitted in the small ends, and the gudgeon pins are an interference fit in the cross-holes. These pins are located axially by circlips. The light alloy pistons of T-slotted type have flat crowns and carry two compression rings and an oil control ring.

While the inclined valves are operated by conventional push rod and rocker gear from a cast iron camshaft, there are some interesting detail features. Sintered hard bronze bushes are used for the front and intermediate camshaft bearings and a copper-tin alloy bush at the rear. For ease of assembly of the camshaft from the rear, the intermediate bearing is of smaller diameter than the rear bearing, and the front bearing is smaller still. Cast iron piston type tappets receive the spherical ends of carbon steel push rods, which have cups at their top ends to receive the spherical end of tappet adjusting screws in the rockers. The carbon steel rocker shaft is carried on four aluminium alloy pedestals, the rockers being assembled one in front of and one behind each pedestal. Distance tubes are fitted between the



There are no acute bends in the exhaust manifold of the Fiat 600 engine



The fan and coolant pump are mounted on the side of the Fiat 600 engine

The V8 engine layout is employed in most American cars. As can be seen from this over-square Oldsmobile unit, the design is very compact and so enables a low bonnet line to be obtained

rockers in place of the more usual coil springs. The valve guides are all identical and are axially located by circlips in grooves round the guides. The lower ends of the guides are flush with the holes in which they are housed, thus giving minimum obstruction to gas flow. To prevent a valve falling into the cylinder should a spring break, circlips are fitted in grooves round the valve stems above the guides.

Citroën

In view of the pronounced trend towards a stroke:bore ratio of 1:1, or less, it is surprising at first sight that for the new Citroën DS19, which has so many technical features of advanced design, the engine retains the 78 mm bore and 100 mm stroke of the existing 2 litre engine. No doubt this feature has been retained to keep the overall length of the unit to a minimum, an important consideration in a front wheel drive vehicle. The stroke:bore ratio is 1·28:1 and the swept volume of this four cylinder unit is 1,911 cm³. Although the cylinder block and crankcase casting is unchanged, the light alloy cylinder head has hemispherical combustion chambers with large inlet and exhaust valves set at an included angle of approximately 60 deg. The valves are operated by push rods and an entirely new rocker assembly, actuated by a single camshaft mounted fairly low in the crankcase.

A Weber twin-choke carburettor of downdraught type is mounted on the water-jacketed induction manifold. Each of the twin chokes supply the four cylinders, but the throttle of the second choke begins to open only when the throttle of the first is fully open, thus giving a progressive action. A four-branch exhaust manifold leads forward to an expansion chamber from which the gases pass to the silencer, which is mounted transversely. With a compression ratio of 7·5:1 the maximum output is 75 b.h.p. at 4,500 r.p.m. The maximum b.m.e.p. and torque are 130 lb/in² and 101 lb-ft respectively. The maximum piston loading is 2·53 b.h.p/in² and the specific power output 39 b.h.p/litre. Peak piston speed is 2,950 ft/min.

Standard

Apart from the engines that are new, or which are new developments of previously existing designs, increased specific power is a feature also of a number that are virtually unchanged mechanically except for minor modifications. A case in point is the 2,088 cm³ Standard Vanguard III power unit. It has a 85 mm bore and 92 mm stroke; the stroke:bore ratio, therefore, is 1·08:1. Modifications have been made to stiffen the crankcase by extending the bosses for the cylinder head studs. Also, big end lubrication has been improved by cross drilling the crankshaft. The sizes of the inlet ports and inlet throats have been increased from 1¼ in to 1½ in, and the compression ratio has been increased from the 7:1 of the Vanguard II engine to 7·5:1.

As a result of this attention to better breathing, allied with the increased compression ratio, the maximum power has been boosted from 65 b.h.p. to 68 b.h.p. at 4,200 r.p.m. The maximum torque has also been increased from 108 lb-ft at 2,000 r.p.m. to 113 lb-ft at 2,000 r.p.m., the maximum b.m.e.p. now being 128 lb/in². Thus, the specific power has been increased from 31·1 b.h.p/litre to 32·5 b.h.p/litre, for piston loadings, respectively, of 1·84 b.h.p / in² and 1·93 b.h.p / in². Obviously the engine is but moderately rated and may, therefore, be expected to give long and trouble-free operation. This conclusion is supported by the fact that the 1,991 cm³ Triumph TR2 engine evolved from it, by fitting wet sleeves of 83 mm bore, now develops 95 b.h.p., the extra 5 b.h.p. being obtained by fitting larger S.U. twin carburettors.

Compression ratios

Another example is found in the Rover 90, the bore and stroke of which remain unchanged at 73·03 mm × 105 mm (2·84 in × 4·14 in), giving a swept volume of 2,638 cm³. However, the compression has been raised from 6·73:1 to 7·5:1. This has had the effect of increasing the maximum power from 90 b.h.p. at 4,500 r.p.m. to 93 b.h.p. at the same crankshaft speed. Similiarly, the effect on b.m.e.p. has been an increase from 125 lb/in² at 1,500 r.p.m., when the maximum torque was 130 lb-ft, to 129 lb/in² at 1,750 r.p.m., giving a maximum torque of 138 lb-ft.

In the review of the engines a year ago, it was remarked that the first step towards obtaining increased thermal efficiency was "to increase the compression ratio to about 7 to 7·5:1," but this year it would appear that an increase to about 7·5 to 8·1:1 has been made. The Rapier, Hunter 75 and Jaguar 2·4 litre, all have an 8·1 compression ratio, while the Sapphire 234, with its larger bore of 90 mm (3·54 in) has a compression ratio of 7·5:1, as also has the new Citroën DS19 engine. Other engines, of British manufacture, that have a compression ratio of 8:1 or higher are the Alvis 3 litre T.C. 108/G, the Aston Martin DB2-4 Mk 2, the Bristol 405, and the Lagonda 3 litre. These are admittedly high performance cars, but they are designed to carry saloon coachwork; for special competition models, a ratio of 9:1 is not uncommon.

American engines

In American engines the upward tendency in compression ratios is even more marked, due doubtless to the horsepower race in which many manufacturers in the United States were engaged a year ago, and also to the availability of higher octane fuel.

Thus, Buick, Cadillac and Lincoln employ a ratio of 9:1, while Chrysler, Oldsmobile and Packard are content with an 8·5:1 ratio in their power units of similar type, that is, of the over-square V8 layout.

Concurrently with these increases in compression ratio, much attention has also been paid by American designers to obtaining better breathing, and high specific outputs have resulted. The 5·23 litre Buick engine, for example, with a bore of 101·6 mm (4 in) and a stroke of 81·3 mm (3·2 in) develops a maximum output of 236 b.h.p. at 4,600 r.p.m., and its maximum torque is 330 lb-ft at 3,000 r.p.m. Accordingly, its specific power output is 45 b.h.p/litre and the stroke:bore ratio is 0·80:1. The 5·42 litre Cadillac, with a bore and stroke of 98·8 mm × 92·07 mm (3·88 in × 3·63 in), develops its maximum power of 250 b.h.p. at 4,600 r.p.m., and its maximum torque of 345 lb-ft at 2,800 r.p.m. Its specific power is, therefore, 46 b.h.p/litre, and its stroke : bore ratio 0·93 : 1. The 6·03 litre Lincoln has a bore and stroke of 101·6 × 93 mm (4 in × 3·66 in), its stroke:bore ratio being 0·91:1. Maximum power of 285 b.h.p. is developed at 4,600 r.p.m. and maximum torque of 401 lb-ft at 2,800 r.p.m. The specific power is 47 b.h.p/litre.

Chrysler have two V8 engines, the smaller, of 4,932 cm³ swept volume, being a square unit of 92·07 mm (3·63 in) bore and stroke. This unit develops 188 b.h.p. at 4,400 r.p.m. and has a maximum torque of 275 lb-ft at 2,400 r.p.m. Its specific power output is 38 b.h.p/litre. The larger engine of 5,430 cm³ swept volume has the same stroke but a bore of 97 mm (3·81 in), the stroke:bore ratio being 0·95:1. The peak output is 250 b.h.p. at 4,600 r.p.m., and its specific power output is 46 b.h.p/litre. A maximum torque of 340 lb-ft at 2,800 r.p.m. is quoted.

The Oldsmobile engine is also over-square, with a bore of 98·4 mm (3·88 in) and a stroke of 87·33 mm (3·44 in), giving a swept volume of 5,318 cm³. Its stroke:bore ratio is 0·88:1. The maximum power of 202 b.h.p. is obtained at 4,000 r.p.m. and the maximum torque of 332 lb-ft at 2,400 r.p.m. Thus, the specific power is 38 b.h.p/litre. Packard have two sizes of V8 engine, the smaller is of 5,243 cm³ swept volume and has a bore of 96·8 mm (3·81 in); the larger is of 5,768 cm³ capacity and has a bore of 101·6 mm (4·0 in). Both have the same stroke of 88·9 mm (3·5 in). The maximum output of the smaller unit is 225 b.h.p. at 4,600 r.p.m., so the specific output figure is 43 b.h.p/litre. Of the larger unit, the maximum power output is 260 b.h.p. at 4,600 r.p.m.; this gives a specific b.h.p. figure of 45 b.h.p/litre.

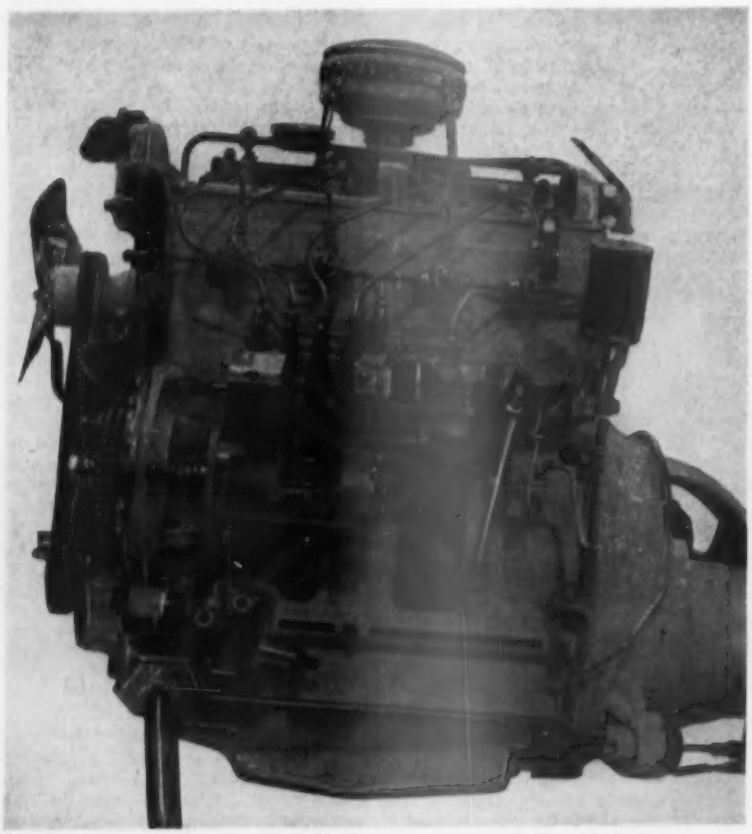
It is interesting to note that, of these American engines, the smaller Chrysler unit alone has a stroke:bore ratio of unity. The others all have stroke:bore ratios of less than unity, with the Buick having the smallest ratio, of 0·80:1. Mean piston speeds at peak output r.p.m. are accordingly reasonably low, no more than 2,450 ft/min in the case of the Buick and 2,660 ft/min in the Chrysler with its 1:1 ratio.

The recent developments in American engines have certainly brought them into line with European standards of specific power output, as can be seen by comparing the foregoing figures with the 44 b.h.p/litre of the Sunbeam Rapier, the 50 b.h.p/litre of the Singer Hunter 75, the 47 b.h.p/litre of the 2·4 litre Jaguar, the 52 b.h.p/litre of the Sapphire 234, the 47 b.h.p/litre of the Aston Martin DB2-4, and the 53 b.h.p/litre of the Bristol 405. A few representative figures for Continental cars are 45 b.h.p/litre for the Alfa Romeo 1900 Super, 40 for the B.M.W. 502, 42 for the D.K.W., 36 for the Fiat 1100, 38 for the Lancia Aurelia, and 45 b.h.p/litre for the Mercedes 300C.

B.M.W.

B.M.W. remain the sole European exponents of the V8 layout, but their engine is now produced in two sizes. The original model, the 502 unit, has a bore of 74 mm (2·913 in) and stroke of 75 mm (2·953 in), giving a swept volume of 2,580 cm³ and a stroke:bore ratio of 1·01:1. A maximum power output of 105 b.h.p. is developed at 4,800 r.p.m., with a compression ratio of 7:1. Its maximum torque is 132 lb-ft. The recently introduced larger engine, used in the type 503, 505 and 507 models, is over-square, having a bore of 82 mm (3·228 in) and the same 75 mm stroke of the original version. The swept volume is 3,168 cm³ and the stroke:bore ratio 0·91:1. A compression ratio of 7·2:1 has been adopted, and the output is increased to 140 b.h.p. at the same rate of revolutions. Thus, the specific power is 44 b.h.p/litre. The maximum torque is 163 lb-ft. At maximum output, the mean piston speed is 2,360 ft/min for both engines, since they have the same stroke and peak speeds; this is a moderate value. These engines have wet liners, a feature also of Citroën, Renault and Standard units.

Slight modifications to existing designs in order to give an increase in power have also been made to some Continental engines. For example, the 2 litre Renault Fregate engine has been increased in size from 1,996 cm³ to 2,141 cm³, by boring out to 88 mm instead of 85 mm; the stroke remains at 88 mm. This gives a stroke:bore ratio of unity. The maximum power output is now 77 b.h.p. at 4,000 r.p.m., instead of 62 b.h.p. at 3,800 r.p.m., and the maximum torque of 108 lb-ft is obtained at 2,200 r.p.m. instead of at 2,600 r.p.m. Better acceleration has



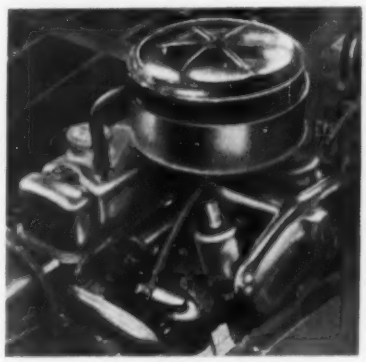
The Standard, four-cylinder diesel engine, of 2,092 cm³ swept volume is a popular unit for installation in taxicabs

naturally resulted from this improvement at the lower end.

The trend towards higher specific powers has been accompanied, of course, by greater attention being paid to cooling. In particular, the cooling of the exhaust valves is recognized as important, and the coolant is accordingly first directed to the areas adjacent to the exhaust valves. In the case of the Singer Hunter 75, the water is brought into actual contact with the exhaust valve guides, since holes are drilled in the guide bosses. In the Lagonda and Aston Martin engines also, the guides are in direct contact with the water. In the Fiat 600 engine and a number of others the exhaust guides do not protrude into the ports.

Petrol injection has made no further headway, doubtless because of the high cost of the injection equipment in comparison with that of the carburettor, and the Mercedes 300 SL remained the only example at Earls Court. This six-cylinder, 3 litre engine of 85 mm × 88 mm (3·35 in × 3·47 in) bore and stroke now develops 240 b.h.p. at 5,800 r.p.m., with a compression ratio of 8·55:1. Its mean piston speed at peak output is 3,350 ft/min and its specific output is 80 b.h.p/litre, both unusually high figures. It is noteworthy that a year ago the maximum power of 240 b.h.p. was quoted as being obtained at 6,100 r.p.m., the maximum torque as 217 lb-ft at 4,800 r.p.m., and the maximum b.m.e.p. as 178 lb/in^2. Now, the maximum torque is given as 216 lb-ft at 4,600 r.p.m., and the b.m.e.p. as 169 lb/in^2.

The highest stroke:bore ratio is that of the Hudson Wasp six-cylinder, 3·3 litre engine, one of the few remaining side valve power units. This engine has a bore and stroke of 76·2 mm × 120·65 mm (3 in × 4·74 in), the ratio being 1·584:1. The mean piston speed at peak output of 115 b.h.p. at 4,000 r.p.m. is 3,170 ft/min. It is closely rivalled in respect of stroke:bore ratio by the A.C. six-cylinder, 2 litre unit, with a bore and stroke of 65 mm × 100 mm (2·56 in × 3·94 in), giving a ratio of 1·538:1. A peak output of 76 b.h.p. is obtained at 4,500 r.p.m., when the mean piston speed is 2,950 ft/min. The Riley Pathfinder 2½ litre engine of 80·5 mm × 120 mm



The twin carburettor installation on the 1½ litre M.G. Magnette engine

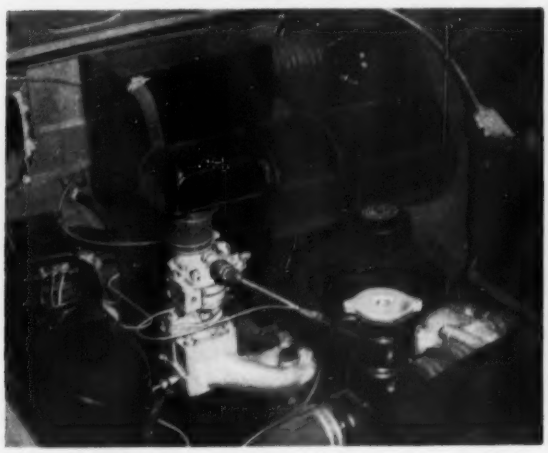
(3·17 in × 4·7 in) bore and stroke also has a stroke:bore ratio approaching 1·5:1, actually 1·49:1. At 4,400 r.p.m., when maximum b.h.p. of 110 is obtained, the mean piston speed is 3,400 ft/min.

The importance of durability is well recognized and the practice of employing a chromium plated finish for the topmost piston ring is extending. So, also, is the trend towards the fitting of oil filters of the full flow type. A commendable move is the location of such filters in an accessible position for easy withdrawal of the element for cleaning or replacement: the value of a filter is largerly offset if inaccessibility leads to neglect. The attention paid to exhaust valve cooling has already been mentioned, and it is, of course, important from the general durability point of view. So, likewise, is the stiffening of the cylinder-crankcase casting exemplified by the latest version of the Vanguard engine.

Briefly, it may be said of engine design that while higher thermal and volumetric efficiencies are being sought, particularly with the few new engines, and with those of recent design which lend themselves to such development, at the same time the policy of rationalization is firmly established amongst the larger or group manufacturers and is extending to the manufacturers producing in smaller numbers, who continue to offer cars of individuality.

Apparently the diesel engine for use in private cars is suffering an eclipse. Attractive as the diesel is from the thermal efficiency, and, therefore, the fuel economy point of view, and despite the improvements which have been effected to secure quieter and smoother running at idling speeds, it has the disadvantages of being less flexible than the petrol engine and still comparatively rough and noisy, except when it is pulling under load. It is also of heavier construction and so more costly than a comparable petrol engine.

It seems that the main reason for the lack of sponsors, amongst car manufacturers, for this type of engine lies rather in the considerable development of the petrol engine during the last few years, since fuel of higher octane rating became available. The increased thermal efficiency of the modern petrol engine has reduced the diesel's advantage in this respect, and it has, moreover, been obtained without detriment to the smooth running and flexibility. While the Standard diesel engine of 2,092 cm^3 capacity was shown in sectioned form and is available in the Vanguard estate car, the Borgward diesel-engined car has been discontinued, so that the Mercedes 180D of 1,737cm^3 capacity and the Fiat diesel-engined version of the model 1400 remain the only other cars of this type on the market.



On the Standard Vanguard III, the breathing system has been improved by modifications to the induction manifold, inlet ports and valves

The Morris Isis has an S.U. carburettor on a two-port, external induction manifold feeding a six port branch tract cored in the cylinder head

CARBURATION AND INDUCTION

Increased Attention Directed Towards Intake Temperature Control to Prevent Carburettor Icing

A WIDE variety of designs continues to be a feature of modern induction systems. In general, on four-cylinder engines, the two port branch induction tract with siamesed inlet valve ports continues to be more popular than the four port branch pattern. On six-cylinder units, both the three port branch tract with siamesed inlet ports, and the four port branch unit with two of the branches siamesed have a considerable following. The six port branch, with all the branches feeding individual inlet valves, is favoured by some engine manufacturers, including Jaguar on the Mk VII and 2·4 units, Armstrong Siddeley on the Sapphire, Daimler on the Regency and Humber Super Snipe. Rolls-Royce and Bentley, after having employed the four port branch design for a number of years, have now gone over to the six port type, and so has the British Motor Corporation.

Exhaust heat is used to a greater extent than coolant for induction hot-spots, and there is no doubt that the exhaust heat arrangement is the better one. However, with overhead valve, hemispherical head engines it is extremely difficult to employ an exhaust heated hot-spot. Almost without exception, the power units of the American models are fitted with thermostatically-controlled hot-spots; a few British and Continental engines are similarly equipped. On the American V8 engines, the thermostat flap-valve is generally on the exhaust manifold of one of the cylinder banks, and the ducts are so arranged that, while the engine is cool, exhaust gas passes through the induction casting; after the unit has become warm the thermostat valve opens and the exhaust gas flow through the induction casting is much reduced.

On the conventional in-line versions of four- and six-cylinder engines, the hot-spot is obtained simply by arranging both the induction and exhaust systems on the same side of the engine, usually with the induction manifold above that of the exhaust. The thermostatically-controlled heat valve is placed in the off-take of the exhaust manifold, and the heat valve spindle is parallel to the crankshaft. This valve is mounted eccentrically relative to the axis of the spindle so that exhaust pressure tends to open it against the tension of the thermostat spring. When the engine is cold or cool, the valve is in the closed position and exhaust gas from the engine cylinders is directed up and around the jacket of the induction-T, so warming the mixture. As the engine warms up, the thermostatic spring loses tension, and permits the flap valve gradually to open, so passing less exhaust gas round the induction tract.

There is a tendency, on British automobiles, towards the adoption of coolant-heated induction manifolds. This comes mainly from the trend towards the use of the hemispherical combustion chamber; for with the exhaust and inlet ports on opposite sides of the engine, it is impracticable to employ exhaust heat effectively.

At long last it appears that the value of controlling the temperature of the ingoing air is being considered. On even a small vehicle such as the Fiat 600, a simple manual control is provided to take cooler air from the engine compartment, or hot air from the region immediately over the exhaust manifold. On the Ford Continental and Lincoln models the temperature of the ingoing air is thermostatically-controlled; this is an excellent feature, and one which might be widely copied.

As in previous years, the carburettors exhibited can be divided into two distinct classes. They are the open-choke and constant-vacuum versions. All the vehicles equipped with the constant-vacuum pattern carburettor are of British manufacture. On the other hand, all the American and Continental cars shown are fitted with open-choke carburettors, and so are many of the British exhibits. Without exception the constant-vacuum instruments are of the horizontal variety, or fitted at an angle of some 30 deg from the horizontal, in what is sometimes called the semi-downdraught arrangement. Nearly all the open-choke carburettors are downdraught layouts many of which, particularly those of American design, are extremely short. This trend towards shorter downdraught carburettors is, of course, dictated by the modern styling of automobile bodies, which necessitates a low bonnet-line, and consequently little under-bonnet space in which the carburettor and air silencer can be accommodated.

Since nearly all the American vehicles have power units of the V8 type, the downdraught carburettors are either of the twin-barrel or the four-barrel variety. The four-barrel carburettors are generally compound, with one pair of barrels functioning all the time, the other two barrels being brought into action for operation at high power output. These extra barrels are brought in and out of action automatically, generally according to manifold pressure.

All the American vehicles exhibited are equipped with automatic chokes for cold starting. Even Ford and Chevrolet, die-hard users of the hand-controlled strangler, have now gone over to the automatic choke. It is an anomaly that while British manufacturers are tending to follow American practice in automatic transmissions, they are drifting away from the now universal American practice of employing automatic carburation features. Very few British exhibits are equipped with automatic chokes. The Renault Fregate is fitted with a Solex carburettor, having a hot air form of automatic starting carburettor, similar in appearance to the American hot air device.

The Humber Super Snipe Mk 4B now incorporates a hand strangler control, in place of the automatic choke device previously fitted to earlier versions of this model. Rolls-Royce is one of the few organizations to retain the automatic choke, which is fitted on both the Rolls-Royce and the Bentley models. While the current trend appears to be towards the elimination of the automatic choke in favour of the hand control, it is possible that this is a flash in the pan. If petrol were to become cheaper, a revival of interest in the automatic choke seems a possibility, or even a likelihood.

Although nearly all the Continental exhibits are equipped with downdraught carburettors, there are a few exceptions. On some Continental models, a tendency towards twin downdraught carburettors of the compound type is noticeable. This arrangement is an application of the compound system, employed on American four-barrel units, to the twin-barrel instrument. Although, as in the case of the four-barrel carburettor, automatic control of the extra barrel is usually effected by manifold depression, sometimes a mechanical interconnection is also included.

The Alpha Romeo Guiletta Sprint, for instance, is equipped with a Solex dual downdraught carburettor of the compound type, and so are some of the B.M.W. models. On the Mercedes 300, two Solex dual downdraught compound carburettors are employed, while the 190SL is fitted with twin Solex dual horizontal carburettors. These are of the compound variety, operated by large diaphragms and bob weight mechanisms. The Mercedes concern continues to be the sole exhibitor of petrol-injection equipped models. These models are the 300C and the 300SL, both engines are of 2,996 cm^3 swept volume. The 300SL was exhibited with petrol injection for the first time last year.

Because of the trend towards lower bonnet-lines, air silencers as well as carburettor designs are showing signs of modification. On the American vehicles, the enveloping type of air silencer, with which a large portion of the silencer encircles the carburettor

instead of being above it or in line with it, are much in evidence. The Holley concern go further, and combine the carburettor with the air silencer in such a manner that the silencer forms a part of the carburettor, yet at the same time the two are easily separated for ready accessibility.

Both British and Continental manufacturers of air silencers are increasingly favouring the external-tube form of unit, with which the silence tuning is carried out mainly by means of a single external tube, perforated along its length. Usually the bore of the tube is tapered towards its intake. All the air going into the engine is taken through this single tube.

In the British version, the air duct that serves the carburettor is usually a wedge-shaped box section fabrication of sheet metal, the narrow end of which fits over the carburettor intake. The silencing unit is suspended from the wider end, and may be either a simple silencer, or a combined oil bath air cleaner and silencer with the silencing tube taken from it. This later version is employed on a number of British exhibits. In other instances the so-called L- or T-type of cylindrical silencer is employed. With the L-type, one end of the cylinder carries an elbow piece which fits over the carburettor intake, so that the air is drawn through the length of the silencer. On the other hand, with the T-type an air duct is taken from half-way along the length of the cylinder, and thence by means of a rubber hose or metal connection to the carburettor intake. Some Continental manufacturers go to great lengths to seal the carburettor completely within the air silencer. B.M.W. products are a good example of this. Many American and Continental air silencers and cleaners incorporate excellent examples of quick-release catches by means of which the unit can be readily removed to give access to the carburettor. This is an essential feature where the air silencer envelopes the carburettor.

Nearly all American cars are fitted with a throttle return damper. This is a diaphragm unit, similar in appearance to a suction advance assembly. Its purpose is to prevent the throttle from closing sharply and so cause stalling when the automatic transmission goes into neutral, a particularly desirable feature during the warm-up period. This device, for convenience, is usually attached to the carburettor where it can work directly against the throttle lever, so many observers assume that it is a part of the carburettor, but actually it is a completely separate unit.

Four-cylinder engines

An interesting exhibit among the new small cars was the Fiat 600. This rear-engined vehicle is powered by a very small four-cylinder overhead valve engine, which embodies several novel features. The cylinder head is cast in aluminium, and the induction system is cored within the casting. A Weber downdraught carburettor is mounted above the induction tract, which is on the right-hand side of the head. This tract which is invisible externally, is of the two port pattern, and the siamesed inlet ports are arranged in the orthodox manner. The four sparking plug bosses are in recesses sunk into the right-hand side of the head casting, and it is between the plugs of numbers one and two, and three and four cylinders, that

On the Fiat 600, the intake to the filter can be adjusted to take in warm or cold air

the ends of the induction tract turn inwards to branch into the siamesed inlet valve ports. A cylindrical air silencer is mounted transversely above the engine, and is connected to the air intake of the carburettor by a right-angle elbow-piece fabricated from sheet steel.

The exhaust system is on the left-hand side of the cylinder head. It is evident from the design of the exhaust manifold that considerable thought has been devoted to the free flow of the exhaust gases. The four separate exhaust branches leave the cylinder head to meet at a point nearly opposite number three exhaust port. Here, the off-take flange for the down-pipe joint is in a vertical plane. The down-pipe is then turned downwards towards the silencer, some four inches from the flange. Fuel supply is by a mechanical fuel pump mounted on the right-hand side towards the rear of the engine crankcase. The fuel tank is under the bonnet at the front of the car.

It is at first sight surprising to find on so small a car an unusual item, which could well be incorporated in every motor car manufactured today. This is an alternative hot or cold air intake to the carburettor. However, the need for such a device to prevent carburettor icing in the winter is greater when the warm air flow through the radiator does not pass over the carburettor.

In this vehicle, the inlet to the air silencer is of unconventional design, in that there are a number of orifices arranged radially around the entry end of the silencer. In addition, a fabricated duct leads from the underside of the entry end of the silencer down to a point above the exhaust manifold. The lower end of the duct is funnel-shaped to collect the warm air. By loosening a fly nut on the end of the silencer and rotating the disc on the outer face, a simple valve is made to close off the cool air intake holes and opens the passage for warm air to pass into the silencer from the exhaust manifold, and *vice versa*. This is an elaboration of the device employed on the Fiat 500, where a similar effect was obtained by pushing in a flap valve. Another point of interest on such a very small engine is the inclusion in the ignition system of a suction advance unit, doubtless employed to obtain fuel economy. Cold starting is effected by an auxiliary starter carburettor, operated by a plunger piston.

The Rootes engineers have had long and successful experience with twin-gallery, ram's horn induction systems, as employed on the Sunbeam Mks I, II and III. It is not surprising, therefore, to find that the new Sunbeam Rapier also incorporates this type of system. This new engine is smaller than the Mk III, being 1,390 cm³ swept volume instead of the 2,260 cm³ of the existing model. Moreover, both the induction and exhaust manifolds are now on the left-hand side of the engine. Mixture is supplied by a Zenith-Stromberg DIF-36 unit, which is a new and shorter version of the instrument used on the Mk III. In general design, the carburettor follows closely on the lines of the earlier model, but small improvements have been made, among which are the new strangler and fast idle system, five screws to secure the float chamber cover, and so on. The cam system of the fast idle mechanism has been redesigned, and the fast idle rod is now connected to the same end of the throttle spindle as is the throttle lever.

The aluminium induction manifold is arranged above that of the exhaust. It contains two separate gallery tracts, the outer ends of which feed the four separate inlet valve ports in the cylinder head. The dividing wall, separating the two tracts, is brought right up to the riser orifice, which is positioned half-way over each gallery. In cross section, the tracts are rectangular at the riser, and change to circular just beyond the point where they curve inwards towards the cylinder head. Both ends of the manifold rise slightly from the riser, and the front branch appears to rise more than the rear one. This is an optical illusion, brought about by the fact that the induction flange for the carburettor is machined at an angle to permit the axis of the carburettor to be vertical, when the engine is installed with a transmission angle of some 5 deg, in the chassis.

Although a thermostatically-controlled hot-spot valve is employed on the Humber Hawk and on the Hillman Minx, neither of the Sunbeam models incorporate this device. As on the

Sunbeam Mk III, the aluminium induction manifold is secured to the exhaust manifold, which is below, by a four-hole flange. The flange of the exhaust is open, so that the hot gases play directly upon the floor of the induction tract immediately under the riser. A drain pipe is taken from this point of the induction manifold and, following usual Rootes practice, a non-return ball valve is fitted to the lower end of this drain pipe. The exhaust manifold is of circular section and is of the four port type, but has a single gallery. Its off-take is directly under the inlet riser.

Air silencing is by means of an A.C. unit; it is of the external tube type. The elbow of this silencer fits directly on the top of the carburettor. To operate the throttle mechanism, a torsion rod used in conjunction with a U-shaped throttle lever on the carburettor is now employed, instead of the Bowden cable control of the Mk III unit. The rod is short, and the end remote from the carburettor is supported by a bracket attached to the induction manifold. An A.C. mechanical fuel pump is fitted on the right-hand side, near the front of the crankcase. It embodies a flat bowl type filter.

Now that the smaller six-cylinder engine is gaining popularity, the introduction of a large four-cylinder power unit comes as something of a surprise. When one considers, however, that the new 2·3 litre, four-cylinder Armstrong Siddeley engine is developed from the well-tried earlier Sapphire model, good results may be expected. Actually, this is a high performance, sports engine, and is used as an alternative power unit for the other small model. The vehicle with the four-cylinder engine is called the 234 and the other model, the Sapphire 236, is equipped with the 2·3 litre, six-cylinder engine.

Surprisingly, the four-cylinder sports version has siamesed inlet valve ports, although the combustion chamber is of the hemispherical type and is virtually the same as that employed in the Sapphire six-cylinder model. Mixture is supplied by twin S.U. carburettors inclined at 30 deg from the horizontal. The carburettors are bolted to the two separate short riser castings of aluminium, which in turn are bolted to the two inlet valve ports on the right-hand side of the cylinder head; these castings are, in fact, riser extensions. To heat the mixture, water jackets are incorporated on the underside of the tracts.

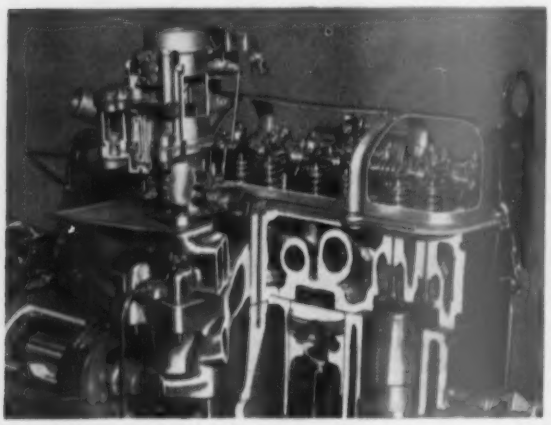
The Renault Fregate has a hot air, automatic starter unit on the side of the Solex downdraught carburettor

Hot coolant is fed from a pipe leading from the side of the cylinder head to the jacket in the rear induction casting. It is then fed into the front induction casting through a copper tube connecting the two, and thence through another external tube to the thermostat chamber. A balance pipe of $\frac{7}{8}$ in bore connects the two induction tracts. For air silencing, a T-shaped air intake casting of aluminium fits over the intakes on the carburettors, and is connected to a long, T-type air silencer mounted longitudinally to the left-hand side of the cylinder head.

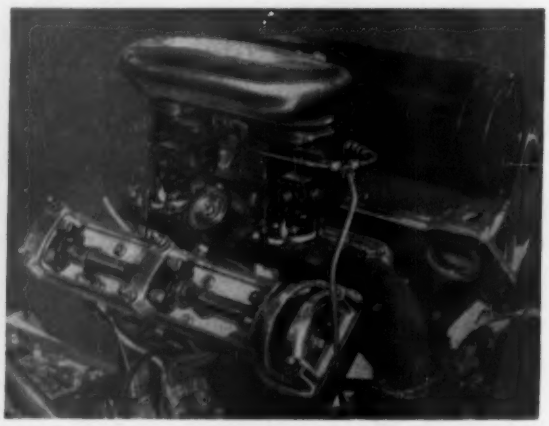
In addition to the Hunter model, Singer Cars Ltd. exhibited a new version, the Hunter 75. This vehicle is equipped with a new engine, having twin overhead camshafts with a chain-drive at the front. The cylinder head is of cast iron, and separate castings carry the camshafts. Mixture is supplied by twin, Solex downdraught carburettors of the 32-PB10-2 type. They are equipped with mechanically-operated acceleration pumps and starter valves of the usual Solex pattern.

The induction manifold is of cast aluminium, and is mounted in the V between the two camshaft assemblies. Each carburettor feeds a short riser tract, which divides into two ducts in the longitudinal plane so that, in effect, each riser is siamesed vertically to form a four port branch manifold. The inlet valves of the hemispherical head are on the right-hand side of the engine, and the four valve ports are rather long and are vertical. This system, reminiscent of the Bristol 405, should result in excellent filling, as the mixture is on a steep downward gradient all the way from the carburettor to the inlet valves. The induction manifold is bolted down on the horizontal gasket face machined along the right-hand side of the cylinder head. This leaves room for the water rail, through which the coolant enters the head, on the inner left-hand side of the V.

Coolant heats the mixture, the manifold, of course, being jacketed for this purpose. The coolant leaves the head through ports in the manifold gasket face to the jacket. Between the two risers a large outlet pipe is taken from the manifold. It is joined by a rubber hose to the inlet at the top of the radiator. In fact, the jackets form the main coolant outlet of the engine. A neat air intake casting, of aluminium, fits over the carburettor intake ports, and is connected to a cylindrical air silencer mounted longitudinally above the left-hand camshaft cover. Fuel supply is by an A.C. mechanical pump.



The four-port cylinder head of the Sunbeam Rapier is fitted with a twin-gallery induction manifold and a Zenith-Stromberg single downdraught carburettor



Solex twin downdraught carburettors are employed on the engine of the Singer Hunter 75 and the induction system is jacketed for coolant heating

The S.U. twin carburettor installation on the Armstrong Siddeley 234, four-cylinder model

A Weber dual downdraught carburettor of the compound type employed on the Citroën DS19

On the Standard Vanguard Mk III, the carburation system has been modified, the induction manifold and the inlet valves and ports being increased in area. The Solex carburettor is retained. As before, the induction manifold is of the four port branch variety, mounted above the exhaust, with a thermostatically-controlled hot-spot and heat jacket round the riser T. Of circular cross section, the galleries are inclined upwards on each side of the riser and drop slightly towards the outer branches. An air silencer of the external tube type is employed. The tube points forwards, towards the radiator. An alteration has been made to the throttle-operating mechanism; the system now incorporates a nylon ball joint to cater for universal movement.

Although it was rumoured that the fuel system of the new Citroën DS19 embodied petrol injection, the engine is actually carburetted in the conventional manner, except that a dual downdraught Weber carburettor of the compound variety is employed. Owing to the fact that the gearbox is in front of the power unit, the position of the engine is such that nearly half of it is under the dash. The four-cylinder power unit has a bore of 78 mm and a stroke of 100 mm, and thus has a capacity of 1,911 cm³. It has hemispherical combustion chambers and a compression ratio of 7·5 : 1. The power developed is 75 b.h.p. at 4,500 r.p.m.

As is to be expected with this form of cylinder head, the induction and exhaust manifolds are on opposite sides of the engine, the induction system being on the left-hand side. A cast aluminium induction manifold of the four port branch pattern is employed. The branches are not separate, but are joined by webs between each pair. A water jacket is incorporated round the riser T, the coolant being fed in and out of the jacket by rubber hose of large diameter.

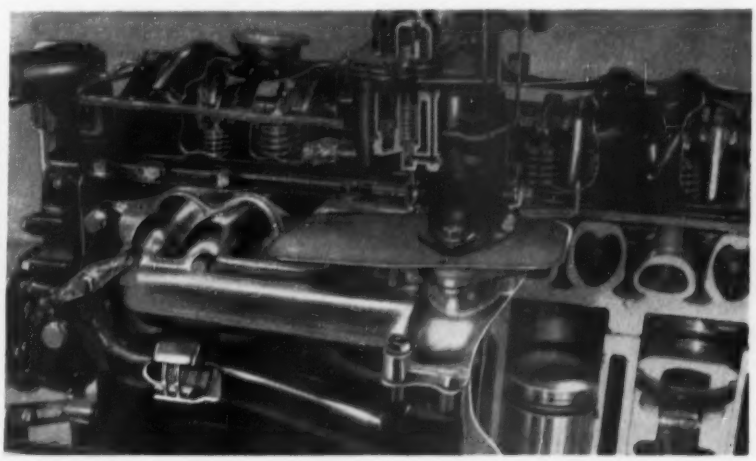
The Weber dual downdraught carburettor is mounted with its throttle spindle in a transverse plane. Both throttle barrels feed into a common mixing chamber, from which the two galleries lead, one to the front and the other to the rear, to the branch ports. Since the manifold is of the straight rake form, the port branches leave the galleries at right angles. The cross section of the tracts throughout is circular.

A carburettor of compound design is employed. Both throttle barrels are in action when high power is required, but for economical cruising, the secondary barrel goes out of action and all the mixture is supplied by the primary barrel. With this installation, the extra throttle barrel is brought into action by a mechanical interconnection between the two throttle valves, and not by manifold pressure as is the case in a number of Continental units. Since the engine is so far back in the frame, the carburettor is just below the extreme rear edge of the bonnet, where there is the greatest clearance above it. Ample under-bonnet space is thus provided for the air intake elbow which fits over the carburettor. From the elbow-piece, a rubber hose connection of large diameter leads to the cylindrical air silencer, which is installed longitudinally along the right-hand side of the rocker cover.

The four port branch exhaust manifold extends along the right-hand side of the cylinder head, and its off-take faces forward. Above the exhaust manifold is a very large metal heat shield. The chief purpose of this is to protect the right-hand hydro-pneumatic suspension sphere from radiated heat, but it also serves to prevent the air silencer from being overheated, lying as it does above the manifold. From the exhaust manifold off-take, the exhaust gases pass to a small primary silencer, and then to a secondary silencer mounted transversely in front of the radiator. From this point, a long tail pipe leads back to the rear of the car. The pipe is of elliptical section, with its major axis horizontal to improve ground clearance. Following usual Continental practice, fuel is fed from the tank to the carburettor by means of a mechanical fuel pump.

Six-cylinder engines

The Jaguar 2·4 litre car is powered by a six-cylinder engine, a smaller version of the 3½ litre unit. Its bore is 83 mm, as in the Mk VIII; the stroke has been shortened to 76·5 mm. In fact, the cylinder head is interchangeable with that of the Mk VII engine, and so are a number of other components. A major change has been made in the carburation system, however, and in place of the twin, large carburettors of the S.U. constant-vacuum type, as employed on the Mk VII and the XK models, smaller twin Solex



The exhaust manifold on the Humber Super Snipe Mk. 4B is in three parts, with piston ring type seals at the joints at each end of the centre component to allow for expansion and to prevent gas leakage

downdraught 32-PBI-5/S, open-choke instruments are fitted.

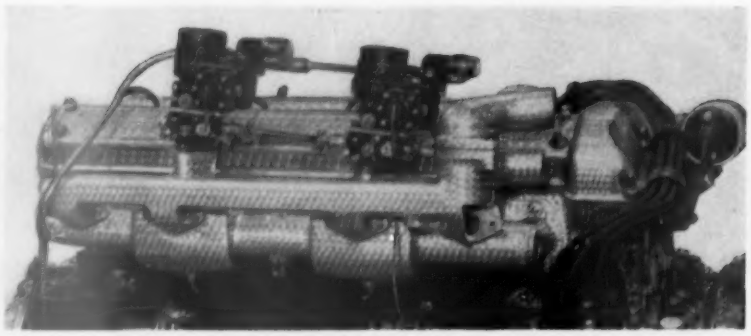
Since these carburettors are small for the swept volume handled, it is evident that the new power unit is deliberately de-tuned, doubtless in the interests of fuel economy. Obviously more power is available, should it be required, for subsequent versions of the engine. It is interesting to note that on the XK 140, the peak of the b.m.e.p. curve occurs at an engine speed of 3,400 r.p.m., while on the new engine the peak is at about 2,400 r.p.m. Much of this reduction of breathing capacity is doubtless due to the restriction in the carburation system, but the camshaft employed is the same as that used on an earlier version of the XK 120 model.

The general design of the induction system is similar to that of the Mk VII, the manifold being placed on the right-hand side of the engine and formed of a single casting in aluminium, with six separate branch ports feeding the individual inlet valve ports in the cylinder head. As on the Mk VII, the carburettors are between the induction branch-ports of the pairs of cylinders numbers two and three, and four and five. The downdraught risers are fairly long, and merge vertically into the main induction gallery, which is of circular cross section. Because of the transmission angle of the engine, the riser of the rear carburettor is longer than the front one. Each carburettor thus feeds three cylinders, and between the two tracts there is a restriction forming a balance orifice and thus partly partitioning the gallery. A drain tube is provided under each riser T-junction.

Hot coolant is employed for heating the mixture, a jacket being formed under each riser where it joins the gallery tract. These jackets are so arranged that most of the hot coolant in circulation passes into them through passages cored in the manifold casting. The orifices of these passages are aligned with similar channels and ports in the cylinder head. Bolted to the outside of the induction manifold casting is a four-port aluminium water rail, the top outlet of which is connected by a rubber hose to the inlet of the radiator. Thus, as in the Singer Hunter 75, the entire circulation of coolant is taken from the cylinder head, through the induction manifold jackets and thence by the water rail to the radiator.

A single air silencer of the Vokes long cylindrical pattern is employed. It is installed transversely above the engine, and is connected to a T-shaped duct, of rectangular cross section, which fits over the intakes of both carburettors. The fuel is supplied by an S.U. electric pump, mounted in a recess in the left-hand side rear wing, an excellent position for avoiding pre-heating of the fuel and subsequent vapour lock troubles.

Twin, three-port exhaust manifolds are fitted on the left-hand side of the engine. The branch ports of cylinders numbers three and four are vertical, while those of numbers one and two, and five and six are turned inwards to join them. The two down-pipes join to form one, some 6 in from the flange joints, and thereafter the pipe leads back to the single elliptical section exhaust silencer, in line with the rear left-hand cantilever spring.



On the Jaguar 2.4 litre model, Solex twin downdraught carburettors are fitted and the risers are of different lengths because of the installation angle of the engine

Much interest was shown in the recently introduced Sapphire 236. The new power unit is similar to that of the earlier "Eighteen" model, but has been developed to produce more power. As in the earlier Sapphire engine, the induction system is of the double-gallery type, with the main gallery tract and its six inlet valve ports cored on the left-hand side of the cylinder head. The combustion spaces, however, unlike those of the 3·4 litre Sapphire, are of the bath tub, or lozenge, form and the inlet and exhaust valves are in line.

A circular section gallery is employed. It is divided in the middle, and a balance orifice is provided for maximum torque and good idling. Following previous design practice of Armstrong Siddeley, the main gallery is served by an external, cast aluminium manifold with a circular section tract. This manifold sweeps round from each side of the riser to the head. Whereas the earlier Sapphire model is unusual in that a four port branch manifold was employed, there are only two branches on the manifold of the 236 model. The two branch ports feed into the main gallery between the inlet valve ports of the pairs of cylinders numbers two and three, and four and five.

An exhaust-heated hot-spot is provided under the downdraught riser, the induction manifold being bolted at this point to the exhaust manifold below it. Twin exhaust manifolds are employed, one for each set of three cylinders. The off-take down-pipes join one another a short distance from the manifold flange joint. These exhaust manifolds are so designed that the hot-spot is taken off the front manifold, which is extended to the rear sufficiently for the hot-spot of the induction manifold to be bolted to it at a point in the middle immediately below the riser, a practice which has become increasingly popular in recent years. A steel plate is clamped between the two manifold flanges, both of which are of the open pattern. Thus, the exhaust gases play directly upon the steel plate. As on the Sapphire 346, the downdraught carburettor is a Zenith-Stromberg unit of the mechanical economizer type, with an acceleration pump, hand strangler and automatic fast idle. The air intake is equipped with an A.C. silencer of the external tube type, the elbow of which fits directly over the air horn of the carburettor.

A newcomer to the Morris range is the Isis, powered by a B.M.C. six-cylinder engine similar in general design to that of the Austin A90 and Wolseley Six-Ninety models. There are, of course, several minor differences, one of which is the employment of a single S.U. carburettor instead of the twin carburettor layout on the Wolseley Six-Ninety, and the single Zenith unit on the Austin A90.

The double-gallery induction system as employed on the A90, first exhibited last year, is a complete break away from previous Austin practice. Whereas the Austin installation incorporates a single downdraught Zenith carburettor, on the new Morris Isis an S.U. semi-downdraught instrument is used. The general scheme of the induction system of the Isis is much the same as on the first B.M.C. A90 engine, but has been modified to suit the S.U. installation. As in the Austin installation, the main induction tract of the Isis is a long circular section gallery, cast in the left-hand side of the cylinder head. From this tract, the six inlet valve ports drop steeply to the individual inlet valve ports. An external two port branch manifold serves the main gallery. The outlet ports of the manifold are opposite the spaces between the inlet valve ports of cylinders numbers two and three, and four and five. Following the usual practice with this system, a balance orifice, some $\frac{1}{4}$ in diameter, is situated in the middle of the main gallery tract.

The exhaust manifolds are below that of the induction system. Cylinders numbers one, two and three discharge into one manifold, while four, five and

six discharge into another. The front two-port external manifold is cast integrally with the front exhaust manifold to provide a hot-spot. As is current general practice with twin exhaust manifolds, the two down-pipes are joined before passing to the exhaust silencer. A large sheet metal heat shield is fitted underneath the carburettor to protect it from radiated heat from the exhaust manifold below. Connecting the cylindrical air silencer with the air intake of the carburettor is an L-shaped box-section casting of aluminium. Following general Morris practice, an S.U. electric fuel pump is employed. For engine breathing, a pipe connects the rocker cover with the tappet cover, and another pipe is taken from the first one to the air silencer.

Although for some years the engines in the Rolls-Royce and Bentley cars have been basically common, previously the vehicles have differed in other respects. However, no such differences exist in the new models, fitted with the pressed steel body, introduced earlier in the year. The new vehicle, which is known as the Silver Cloud, replaces the Rolls-Royce Silver Dawn model.

Both of these vehicles are equipped with the new power unit, which now has a bore of 95·25 mm, instead of the 92 mm of the previous versions. The stroke of 114·3 mm is unaltered, so the swept volume is now 4,887 cm³, a considerable increase over the previous figure of 4,556 cm³.

Instead of the four-port induction system, with the inner ports siamesed, as employed on the previous Rolls-Royce and Bentley models, the new engine has a six-port induction tract. One half of this tract is sunk in the side of the cylinder head and the other half is formed in the aluminium cover plate which is bolted to the cylinder head. This cover plate carries the two ports and flanges for the twin horizontal S.U. carburettors. Each carburettor feeds three cylinders. From the gallery tracts, the six individual inlet ports drop to their respective overhead inlet valves. A partition in the middle of the main gallery incorporates a balance orifice, so the tracts are separated in the usual manner.

An unconventional feature of the induction scheme is the situation of the carburettor outlets in relation to the inlet valve ports in the cylinder head. In most installations of this type, it is usual to place the carburettor outlets either between the inlet valve ports of cylinders numbers one and two, and four and five, or between numbers two and three, and four and five. In the Rolls-Royce and Bentley design, however, the carburettor outlets are almost opposite the inlet valve ports of numbers two and five cylinders. As in the previous range of engines, the new power unit has an F-head, with overhead inlet and side exhaust valves; so, possibly, cylinder head stud problems dictated the porting arrangement.

As with the previous models, the induction system and carburettors are on the right-hand side of the engine, with the exhaust manifolds on the left. The twin horizontal carburettors, which appear to be very widely spaced, are arranged so that the float chamber of the foremost carburettor is at the front of the instrument while that of the other carburettor is at the rear. This is doubtless to prevent excess fuel reaching the engine cylinders when the car is standing on a steep hill, for while the front carburettor may flood, the rear one cannot. Riley also employ this scheme on the Pathfinder.

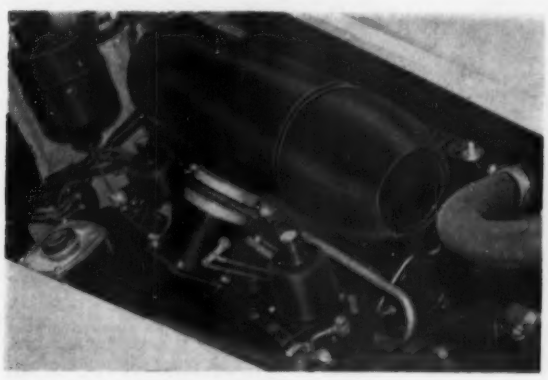
In 1952, Rolls-Royce introduced on the Bentley an automatic choke system of the Zenith pattern, like that which has been used for some years on the Rolls-Royce Silver Wraith. A similar arrangement is employed on the new engines. As in the previous range of Bentley models, a long cylindrical air silencer is installed longitudinally above the rocker cover. From the centre of the silencer an inverted Y-piece of cast aluminium leads to the air inlet of the two carburettors. The strangler valve of the automatic choke system is in the vertical leg of the Y-piece, the valve disc being pivoted eccentrically relative to the axis of the air passage, which is common with automatic choke devices. In this engine, the thermostat is similar in design to the Zenith unit used on the Silver Wraith, except that the spindle is lengthened to accommodate a pair of bi-metal thermostat springs instead of the single one employed in Zenith applications. It is fitted into a coolant-heated recess; the strangler valve is closed when cold and gradually opens as the engine warms up.

Linked to the control mechanism is a fast idle cam. This is to prevent the engine stalling when cold or cool. In the previous models, when the engine was being started, the strangler valve was held positively closed by a solenoid wired in circuit with the starter motor switch. In the current installation the solenoid is in the ignition circuit. This circuit is broken by a pressure-sensitive switch placed in the oil gallery, so that when a certain oil pressure has been built up, the solenoid goes out of action. In addition, a temperature-sensitive switch is also included in the system. The purpose of this is to put the choke out of action at normal running temperatures.

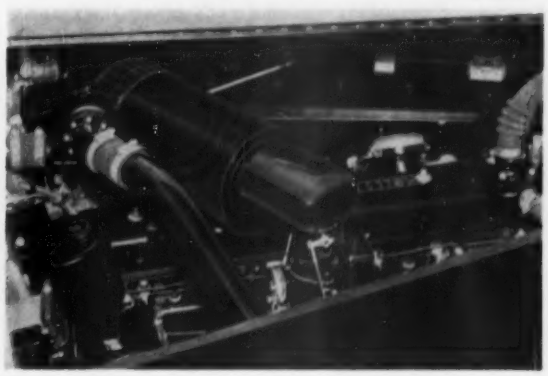
A change has also been made in the construction of the S.U. carburettors. The jet block with cork sealing rings has been discarded; instead, the jet member is now mounted on a diaphragm. This permits the necessary vertical movement for mixture adjustment and at the same time provides a perfect seal. The slow running speed adjustment has also been altered. In the new scheme, the throttles are completely closed when the engine is idling, and a small quantity of mixture for idling is brought through a duct to the engine side of the throttle valves, as in the Amal carburettor of some years ago. A small, spring-loaded adjustment screw on each carburettor controls the quantity of idling mixture by-passing the throttles. For cold starting, the jet sleeve is lowered to increase the area of the jet orifice and a cam system opens the throttle to provide the fast idle.

An interesting item is the fitting of Neoprene rings over the edges of the throttle spindle coupling discs. These discs are very thin and may have sharp edges. The rings are provided to prevent operators from cutting their fingers when working on the carburettors.

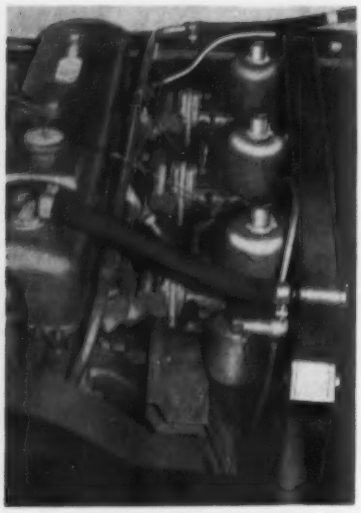
No major change has been made to



Two S.U. carburettors, with automatic chokes, are employed on the Bentley models shown this year



An automatic choke is also used in the Zenith single downdraught carburettor installation of the Rolls-Royce Silver Wraith



An unusual type of air intake and silencer, manufactured by Vokes Ltd., is fitted on the Jensen 541

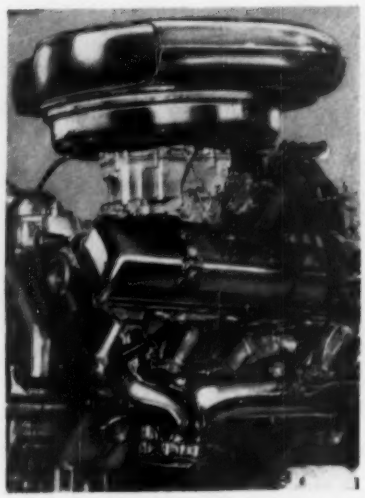
the carburation system of the Silver Wraith, but the engine size has been increased by the same amount as in the Silver Cloud and the Bentley. On this model the four port branch induction manifold has been retained. The two inner branches feed the siamesed inlet valve ports of cylinders numbers two and three, and four and five, while the two outer manifold branches supply single inlet valve ports. Since the exhaust manifold is on the opposite side of the engine, coolant heat is provided to heat the mixture. The riser-T is jacketed as far as the centre ports.

A single Zenith-Stromberg 42-DBVC downdraught carburettor with an automatic choke is retained, but with increased venturi size to suit the greater swept volume. This installation is one of the few remaining systems incorporating the automatic choke, and is the only one in which the classic form of automatic choke is employed in conjunction with coolant heat instead of exhaust. In this instance, the Zenith thermostat unit is housed in a recess cast in the coolant jacket surrounding the central portion of the induction manifold, and a light metal rod connects the thermostat lever with that on the strangler spindle. As before, fuel supply is by means of an S.U. electric pump which, to avoid heat pick-up, is mounted on the chassis. An air silencer of the L-type is installed transversely above the engine.

On the Jensen Interceptor, the single Zenith-Stromberg downdraught carburettor, with an automatic choke, is retained. This power unit is, of course, almost identical with that of the Austin Princess, which has the same carburation system. On the Jensen 541, however, three S.U. carburettors are employed in conjunction with an unconventional type of air intake and silencer. The three carburettors are mounted horizontally. Each is bolted to a short riser casting, which bends downwards sharply to meet its individual inlet valve port in the cylinder head. A balance pipe of large dimensions extends across the top of all three risers.

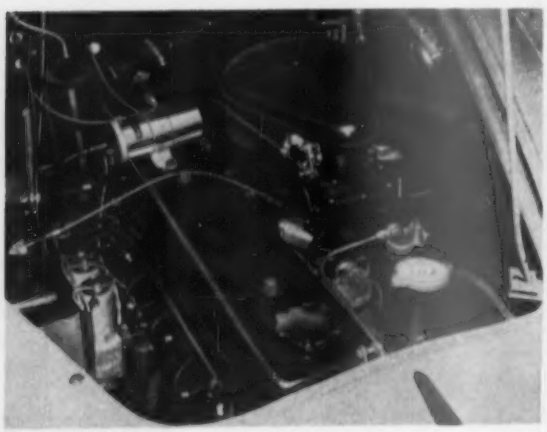
The Burgess air intake and silencer takes the form of a large box, some two feet long by one foot deep at the front, becoming shallower at the rear, and about 1½ in wide. It is attached to the intakes of the three carburettors. The actual opening for the air intake is at the front; although the area of this opening appears to be small, it must be sufficient in view of the known performance of the car.

In the normal process of development, the power of the Humber Super Snipe overhead valve engine has been increased by the employment of a larger induction manifold and a bigger carburettor venturi. On this model, known as the Mk 4B, an alteration has also been made to the exhaust manifold. Both the inlet and the exhaust manifolds are on the left-hand side of the engine. The six port branch induction manifold



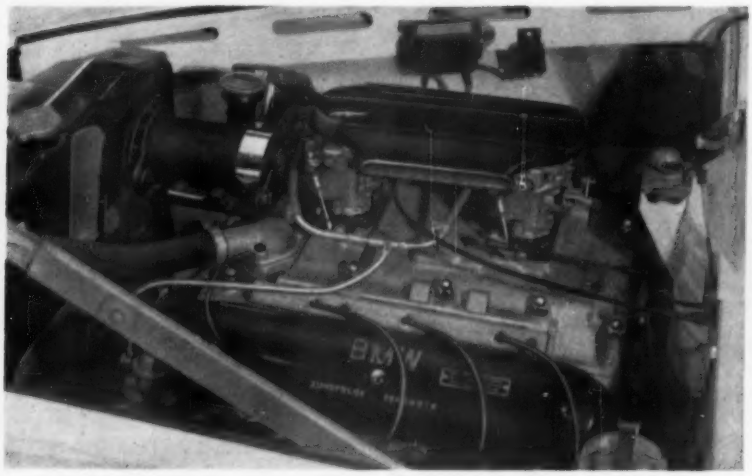
The Oldsmobile Rocket engine is a typical example of current American practice in air silencer design

is of aluminium and is bolted to the exhaust manifold, which is below it, at a point underneath the riser junction. A thin plate of stainless steel is clamped between the hot-spot flanges, and the exhaust gases play directly on this plate, so effecting a quick warm-up from cold. In previous versions, the exhaust manifold was cast in a single piece. However, on the new model, three separate castings are employed. The centre piece, which carries four port branches as well as the hot-spot and off-take flanges, forms the largest casting. The two extreme port branches serve cylinders numbers one and six and are small separate castings. These fit into recesses in the open ends of the centre casting, in each of which are machined grooves to carry two seals of the piston ring type. This arrangement is by no means a new idea, but it is an effective way of providing for expansion. Daimler Co. Ltd., it will be recalled, employed this scheme many years ago on their large six-cylinder engines.



On the Armstrong Siddeley 236 model, a single Zenith-Stromberg downdraught carburettor is employed

The Lincoln Premier V8 engine has a thermostatically-controlled valve close to the right-angle bend in the air intake duct



A neat induction manifold casting is used on the B.M.W. 507 V8 engine

Eight-cylinder engines

Nearly all the American cars exhibited had V8 power units, and the carburation, induction and exhaust manifold systems of these engines, unlike those of four- and six-cylinder engines, have become standardized. Continental V8 engines follow much the same trend. On almost all units of this type, the induction system is contained in a massive casting that bridges the V and embodies eight induction channels arranged in sets of two, with one above the other. The carburettor is invariably of the downdraught pattern, and has either two or four barrels. It is mounted in the middle of the manifold casting. With the dual type of carburettor, the induction tracts are so arranged that one barrel feeds the two inner cylinders in one bank and the two outer cylinders on the other, or *vice versa*. Both versions are in common use. The riser T-junctions are at different levels; this is to permit the tracts to cross over one another.

When the four barrel type of carburettor is employed, the only difference is that instead of a single barrel feeding its own tract, two barrels, one primary and the other secondary, serve the tract. Also incorporated in the induction casting are the exhaust hot-spot ducts and, in many instances, the outlet ducts to take the coolant from the cylinder head on each bank to the outlet to the top of the radiator. Exhaust hot-spot ducts in most instances pass through the casting from one bank to the other, the flow of exhaust gas being controlled thermostatically by a heat valve in one of the exhaust manifolds. In this type of engine, the exhaust manifolds are on the outside of each bank.

On American engines, the enveloping type of air silencer is the rule; the silencer and cleaner unit surrounds the carburettor instead of being above it. The neatest V8 induction system design is that of the B.M.W. 507, in which a pair of Solex dual downdraught carburettors are employed. An unusual feature is that the top of the manifold casting is flat, and there is no sign of the channels and ducts, which are usually so evident in this form of design. Equally neat and effective is the arrangement on the B.M.W. 502. A single Solex downdraught carburettor is entirely encased in the air silencer, which fits closely on a ringed boss cast on the induction manifold. This air silencer is of the external tube type and is fitted with three quick-release catches, a most commendable feature.

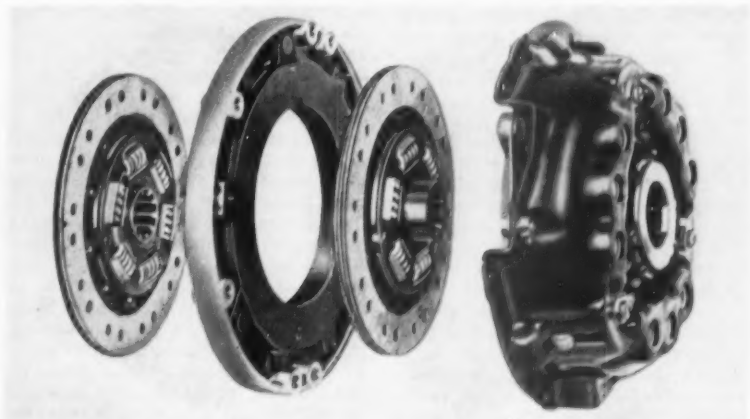
CLUTCHES

Further Progress Towards Elimination of Pedal Control

SINCE most car owners, at least in this country, seem to be content with the pedal-controlled dry plate clutch, and variations from the orthodox layout generally incur additional cost, it is not surprising that there is little change in the standard equipment on the large majority of cars represented at Earls Court. Nevertheless, it is evident that much is being done to meet the small but growing demand for simplified methods of control. Some of the larger and more expensive types of car are equipped with fully automatic transmissions; but semi-automatic systems, embodying a clutch that is actuated hydraulically, pneumatically or electrically, and controlled by the change speed lever, are employed in some of the less expensive vehicles.

An example of the semi-automatic type of system is the Manumatic transmission supplied by the Automotive Products Co. Ltd. It consists essentially of a servo-operated clutch, a control unit, vacuum reservoir and gear lever switch. The Manumatic system can be installed in conjunction with any normal synchro-mesh gearbox, and major modifications to existing design are not needed. This system is relatively inexpensive, and, in view of the advantages it affords, is undoubtedly attractive.

Meanwhile, the majority of cars exhibited at the Show have conventional clutches, pedal controlled. Although the adoption of hydraulic actuation has extended, direct mechanical operation is retained in many instances. Whatever may be said against mechanical opera-



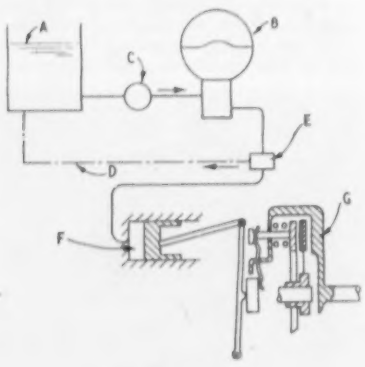
Borg and Beck, 8 in diameter twin-disc, A.S. type, strap drive clutch

tion, it has the advantage of not being subject to the risk of becoming inoperative owing to failure of a hydraulic system, though it must be conceded that such failures are rare and can be prevented by normal maintenance attention. The hydraulic equipment could hardly be simpler, and provision for the mounting of the slave cylinder is now more generally included in the design of the bell housing.

Borg and Beck have now introduced a new range of strap-drive clutches for high performance cars. This range includes both single-disc and twin-disc models in the 8 in and 9 in sizes, although nearly all cars are still equipped with single disc clutches. The torque range varies from 300 lb-ft for the 9 in diameter unit to a maximum of 100 lb-ft for the 8 in diameter single-disc clutch. These figures are for normal passenger car applications, with maximum engine speeds of 8,000 r.p.m. and 9,000 r.p.m. for the 9 in and 8 in units respectively. The special feature of the strap-drive design is that the drive to the presser plate is taken by a number of tangentially disposed spring steel straps which deflect when the clutch is released, without disturbing the concentricity of the presser plate. This arrangement eliminates metal-to-metal rubbing contact and friction, so there is neither wear, backlash nor noise, while accurate balance is retained throughout the full travel.

Three straps riveted to the cover interconnect the three release mechanism support brackets mounted in the cover. This forms a very rigid triangular assembly. The intermediate presser plate of the twin-disc clutch is allowed slight movement against small springs on the mounting pins. This has the effect of quickly separating the front disc upon disengagement.

An exceptionally interesting clutch control system is that included in the hydraulic installation of the new Citroën 2-litre DS19 saloon car. This system is also employed to actuate the brakes, steering, gear shift and suspension. The hydraulic pressure is generated by a belt-driven, seven-cylinder pump, which draws fluid from a reservoir and delivers it under high pressure into a main hydraulic accumulator, where the pressure is maintained at a constant value by a control valve.



A Reservoir
B Main accumulator
C High pressure pump
D Return
E Valve
F Cylinder
G Clutch

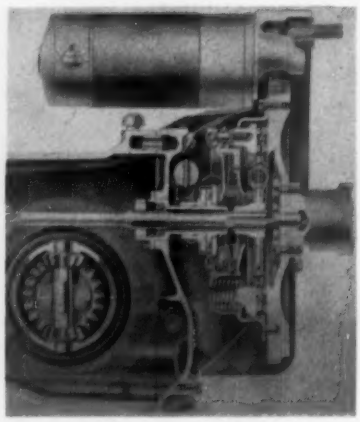
Diagram of hydraulic circuit for clutch actuation on the Citroën DS19

The conventional single dry-plate clutch is disengaged hydraulically when a valve admits fluid under pressure from the accumulator into the operating cylinder. Release of the fluid allows the clutch to engage. Control is effected automatically by a connection to the change speed lever. Movement of this lever leads to withdrawal of the clutch before a gear is selected, and re-engagement immediately after. There is also a connection to the accelerator pedal, to vary the speed of clutch engagement at the will of the driver. Declutching is effected automatically when the engine speed falls to a predetermined minimum. By an additional over-riding manual control on the dashboard, pressure in the operating chamber can be released to engage the clutch when the engine is stationary.

Another automatic clutch, giving two-pedal control, is now available for installation with a synchro-mesh gearbox. It is the Ferlec unit developed by Ferodo. This clutch is an electromagnetic unit and was fully described in the February 1954 issue of the *Automobile Engineer*. Now, it is an optional feature of the Renault 750 and the Panhard cars.

Briefly, the clutch comprises a coil, contained in the flywheel, an armature ring which is allowed limited axial movement but located against rotation relative to the flywheel by three spring steel tangential trailing links, the ends of which are attached to the flywheel and the ring, and a driven plate interposed between two spider plates. One of the spider plates is attached to the flywheel and the other to the armature ring. That attached to the armature ring acts as the presser plate. There are also three trailing tangential leaf springs, one end of each of which is riveted to the driven plate; the other end of each carries a button that bears lightly against the presser plate. When the clutch is disengaged, the drag of these buttons on the presser plate takes up the play in the system, but is insufficient to move the vehicle.

The electrical system includes a two-way change-over switch on the instrument panel. This is employed to take the current supply from either the dynamo or the battery. There is a second switch incorporated in the gear shift lever and a third is connected to the gear selector mechanism to bring into circuit one of two groups of resistances of a rheostat, according to whether the first or reverse gears, or one of the remainder are engaged respectively. These resistances automatically regulate the current, and thus the strength of the electro-magnet of



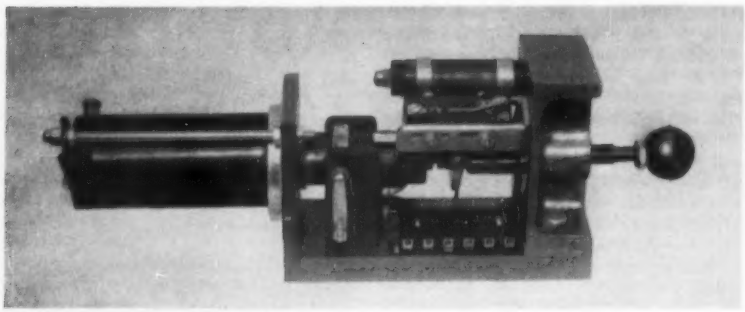
Cross section of the Fiat 600 clutch

the clutch, to suit the gear selected and throttle opening. A control unit located beside the engine contains a rheostat actuated by the accelerator pedal, an adjustable resistance, a fixed resistance, which is short circuited by a switch on partial depression of the accelerator pedal, a relay controlled by the gear lever switch and a condenser to prevent arcing of the relay contacts.

To engage the clutch, current is passed through a carbon brush and insulated slip ring at the rear of the presser plate, and thence by a flexible strip to an insulated terminal on the flywheel. This terminal is connected to the coil. When the coil is thus energized, its magnetic field clamps the driven plate between the presser and spider plates, and the drive is taken up. When the current is cut off, the clutch is disengaged by the action of three coil springs.

For ordinary driving, dynamo current is directed by a two-way distributor switch through one or other of the rheostat resistances, according to which gear is engaged, and the electrical resistance is progressively reduced as the throttle is opened. It then passes through the resistance in the control unit and across the relay contacts, unless these are opened because the relay circuits are made by movement of the gear lever. When the engine is idling the current is inadequate to engage the clutch but it increases with the speed of the dynamo as the accelerator pedal is depressed. This pedal movement also progressively reduces the resistance of the rheostat so that the drive is taken up gradually. Movement of the gear lever for up or down changes causes the relay to break the circuit and disengage the clutch; re-engagement occurs when the lever is released.

No matter what gear is engaged, the vehicle can be stopped by releasing the accelerator pedal and applying the brakes, and the engine can be used as a brake at engine speeds above idling. Should the starter motor fail, the engine can be tow-started. To tow-start, the vehicle can be towed with the change-over switch in the neutral position to



A model of the master controller of the Helecs Elexmatic-Transmittor

cut off current to the clutch, and with a gear engaged; at an appropriate speed, battery current is switched on to engage the clutch and thus turn the engine. Subsequently, the dynamo current should be switched into the circuit. Battery current can be used if it is necessary to drive the vehicle in the event of dynamo failure, and also to hold the car on a gradient with a gear engaged.

The semi-automatic, Elexmatic-Transmittor developed by Helecs Vehicles (Manufacturers) Ltd., makers of the Helecs electric vehicles, is another new two-pedal control system available at low cost for most cars with either crash or synchromesh gearboxes. Initially the aim during the development of this system has been at simplicity. However, should further refinements be required by motor manufacturers, these can, of course, be incorporated. The system has been adapted to a Morris Minor car, the flywheel of which was machined out to accommodate the coil of the electro-magnetic clutch. When the modification was completed, the weight of the flywheel was practically the same as before. Moreover, the new clutch was accommodated without alteration to the housing.

The main features of the unit are an electro-magnetic clutch, with a maximum current requirement of 3 amps, and a master controller unit operated by the accelerator pedal. Current is supplied from the battery instead of from the dynamo as in other units. The coil of the electro-magnet is housed in the engine flywheel, and the current is supplied through a slip ring immediately in front of it. A friction lining is secured to the rear face of the flywheel, to which, when the coil is energized, the driven plate is attracted.

The master controller unit comprises a shaft, at one end of which is a piston in an air-dash-pot cylinder and the other end is connected to the accelerator pedal. This shaft carries a resistance coil wound on an insulator. Axial movement of the shaft causes the coil to slide between a pair of electrical contacts to increase or decrease the resistance in the circuit through which current is fed to the electro-magnet of the clutch.

When the accelerator pedal is in the released or in the slow running position, the actuating rod of the master controller is held, at the end of its travel in the dash pot cylinder, against the action of a return spring; also, the circuit to the clutch coil is broken. The initial movement of the accelerator pedal closes a micro-switch and completes the circuit to the clutch coil. When the accelerator pedal is depressed further, the operating rod returns freely, under the action of the spring, except inasmuch that its rate of return is regulated by the dash pot. The movement of this rod causes the coil to slide between the pair of electrical contacts, and so reduces the resistance in the circuit to the clutch coil. This causes the drive to be taken up progressively.

To change gear, the throttle pedal is released to break the circuit to the clutch (a free wheel is incorporated to allow this to be done without slowing the progress of the car). The gear shift lever is then moved to select the appropriate speed, and then the pedal is depressed again to engage the clutch. When any gear is selected, a switch is closed in another circuit. This circuit serves a solenoid that actuates a plunger which locks the selector rod to prevent the gear from sliding out of engagement. A filter circuit is brought into action when the gear shift lever is in the neutral position. This feeds a small current to the clutch coil to spin the plate to assist engagement of the gear.

TRANSMISSION

Further Developments in Overdrives, Automatic and Semi-Automatic Systems

IN the United States, prior to the introduction on a large scale of automatic transmissions as an optional extra, the overdrive also was widely offered as an extra. It is not surprising, therefore, that so far as the British domestic production is concerned, overdrive units are now standard on six models, available as an optional extra on fifteen models, and can be fitted as a conversion, without the vehicle manufacturer's official approval, on five others. Automatic transmissions are standardized on three models and available as an optional extra on three more.

From the technical point of view, an overdrive has the advantage that a high top speed ratio can be chosen to reduce engine noise and petrol consumption, since the next lower ratio is readily available for acceleration, overtaking, and fast main road hill climbing. This cannot be said of overdrive top speed ratios obtained by normal gear change methods and incorporated in a normal gearbox, since such an arrangement does not give the advantage of the easy change between the two top ratios. It is simply a different approach to the problem of arriving at a suitable compromise between the final drive and gearbox ratios.

Laycock de Normanville overdrive

A new small overdrive unit manufactured by the Laycock Engineering Co. Ltd. is now available as standard equipment on the Sunbeam Rapier. The earlier unit, which was larger, is still in production and is at present used in all the other applications. The new unit differs slightly from the previous one, in that it has helical teeth on the gears and does not incorporate a hydraulic reservoir. Essentially, the overdrive consists of an input shaft, an epicyclic train, a free wheel, an output shaft, an oil pump and a two-way cone clutch.

The input shaft is splined to the planet carrier of the epicyclic train and the inner, driving, member of the free wheel, while the outer member of the free wheel is attached to the output shaft and the epicyclic annulus. The sun wheel and clutch cone are secured together and are free to rotate on the input shaft, but they can be clutched either to the casing or to the annulus.

In direct drive, power is transmitted from the input shaft through the free wheel to the output shaft. Since the sun wheel and clutch cone are forced into engagement with the annulus by the clutch springs, they take over-run torque and, of course, also share the drive torque with the free wheel.

To engage overdrive, the clutch cone is moved from the annulus into engagement with the casing to hold the sun wheel stationary. During the initial stages of this motion, the drive is taken through the free wheel. When the sun wheel is held, the input shaft drives

the planet carrier and planets, while the annulus rotates at increased speed.

Gear teeth of helical form are employed so that the axial component of the load at the meshing points is applied to the sun wheel which, on drive, tends to press the clutch cone into engagement with the conical surface in the casing. It is because of this servo action, that it has been possible to eliminate the pressure oil reservoir, or hydraulic accumulator, and thus simplify the unit. Oil is supplied under pressure by a plunger pump actuated by an eccentric on the input shaft.

It can be seen that the drive is maintained continuously during the change from direct to overdrive and that overrun drive also can be transmitted continuously in both direct gear and overdrive. These features are claimed as advantages of this design, which was the first, and for a long time the only, unit available to manufacturers in this country. It is now standard initial equipment on six cars: Austin-Healey 100, Bristol 405, Jensen Interceptor and 541, and Sunbeam Alpine and Rapier. It is an optional original fitment on the Armstrong Siddeley 2·3 litre, Humber Hawk and Super Snipe, Jaguar 2·4 litre and Mk VII type M, and XK 140, Sunbeam Mk III, Vanguard III, Vanguard diesel and Triumph TR2. Conversions, not officially approved by the vehicle manufacturers, are available for Ford Consul, Zephyr and Zodiac, Vauxhall Wyvern, Velox and Cresta, and Austin Princess, Sheerline and A90.

The Laycock de Normanville overdrive is offered with a choice of ratios from 0·83 to 0·72, that is, 1·2 to 1·4 inverse ratios. This choice of ratios enables the vehicle designer to match the overdrive unit to the characteristics of the car to which he wishes to apply it. In some instances, the choice of control to be adopted is influenced by the ratio used. For instance, on the Bristol 405, the inverse of an overdrive ratio of 0·77, that is 1·3, is so near the ratio of third speed, 1·29, that there would be no point in using overdrive third. The Bristol accordingly has a hand-operated switch control with a trip arrangement, so that changing down from top automatically knocks out overdrive. On other cars, the overdrive may be available on the top two ratios, as for instance on the Austin-Healey, and the Vanguard. It may also be controlled purely by a hand switch or by a governor with an overriding switch.

Borg-Warner overdrive

It is claimed that six and a half million American cars are fitted with the Borg-Warner overdrive unit. Now, manufacturing facilities are being set up in this country. As a result, it is specified as an optional extra for the Austin A90, Ford Zephyr and Zodiac, Morris Isis, Riley Pathfinder and Wolseley Six-Ninety. In the United States it is fitted on Studebaker, Ford, Frazer, Hudson, Kaiser, Lincoln, Mercury, Nash, Packard and Willys cars.

The components of the British version of this overdrive are, in general, identical with those of the unit that has been made in large quantities in the United States. However, some changes have been made to suit manufacturers in this country: for example, steels to the British Standard, instead of to the S.A.E. specifications, are employed. The unit consists basically of an epicyclic gear train with helical teeth. Its input shaft, which is the normal gearbox output shaft, is connected to the planet carrier, while the annulus is connected to the output shaft. The sun wheel is free to rotate on the input shaft. Between the input shaft and the output shaft is a free wheel, which transmits the normal direct-drive torque.

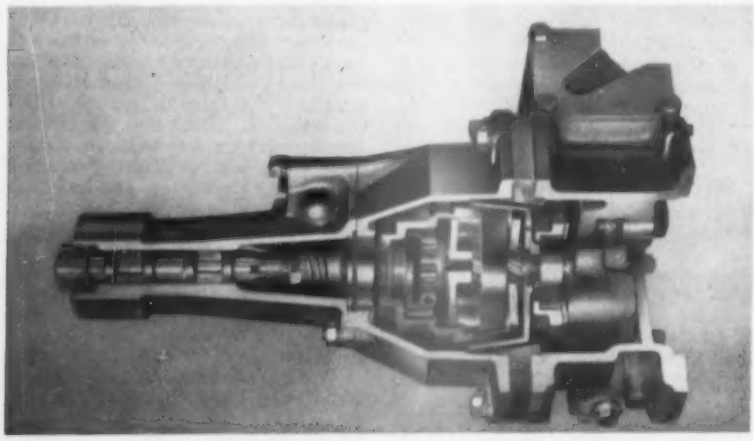
On the planet gear, there is a dog-tooth ring in addition to the teeth that engage the planet gears. When the sun wheel is moved axially, these dog-teeth engage a set of teeth inside the planet carrier and the epicyclic train is locked. This feature is included so that overdrive can be locked out if desired, and also so that over-run braking of the car by the engine is available, for example, for descending long, steep hills. When the unit is unlocked, the free wheel prevents over-run braking and, it is claimed, permits easy gear changes to be made below the overdrive cut-in speeds and also slightly improves the petrol consumption.

The mechanism for engagement of overdrive is as follows. There is a second dog-tooth ring on the sun wheel, with more widely pitched teeth, opposite which is a pawl. When the road speed increases to the predetermined figure, the governor makes an electrical contact, which, acting through a relay, energizes a solenoid that pushes the pawl into engagement with the dog-teeth. So long as the sun wheel is rotating in a forward direction a baulk ring prevents the pawl from engaging. If, on the other hand, the throttle pedal is released, the engine speed, of course, falls, and when it drops to 0·7 of the propeller shaft speed, the sun wheel is stationary. Further reduction in engine speed causes the sun wheel to move in the reverse direction. This, by friction, moves the baulk ring out of the way of the pawl which then drops into engagement with the dog-teeth to hold the sun wheel, and engage the overdrive. The planet carrier, driven by the input shaft, rotates round the stationary sun and drives the annulus at a greater speed.

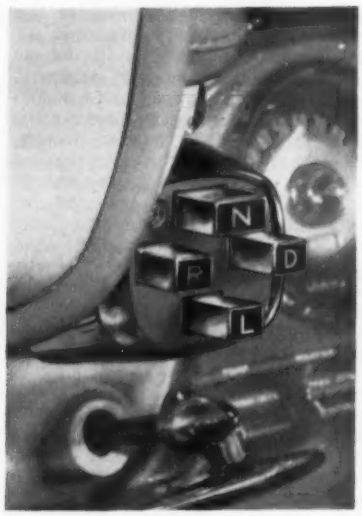
Thus, to engage overdrive, it is necessary to lift the foot from the throttle pedal long enough to allow the engine to slow down to 0·7 of its original speed. The cut-in speed is normally in the range of 30-35 m.p.h. When the speed of the vehicle is reduced, the overdrive remains in engagement until a speed of about 5 m.p.h. below the cut-in speed is reached. Overdrive is obtainable, of course, in any gear on which the vehicle speed can exceed the cut-in speed.

Direct drive can be obtained simply by kicking down the accelerator pedal. This breaks the solenoid contact, and also momentarily breaks the ignition circuit. When the solenoid ceases to be energized, spring-loading tends to disengage the pawl, but is prevented from doing so by friction due to the sun wheel reaction. Breaking the ignition circuit cuts out that reaction and so releases the pawl which, when it reaches its disengaged position, remakes the ignition circuit. This action is rapid and generally only a few explosions are interrupted in this way.

A large current is supplied to the solenoid to move the pawl into engagement, but once engagement is complete, the current is reduced to a lower value, which is all that is necessary to hold the pawl in engagement. In the model offered in this country, if the throttle



This small overdrive unit, manufactured by Laycock Engineering, Ltd., has been introduced for the Sunbeam Rapier. It has helical teeth, the thrust from which assists overdrive engagement



Chrysler and Dodge cars now have a push-button control for their automatic transmission

were to be held open above the overdrive cut-in speed, the large initial current could continue to flow, but in other models, a switch is incorporated to prevent this. Also, when the overdrive is locked out by engagement of the sun wheel dogs with the planet carrier, the high current flows through the solenoid as long as the vehicle speed is above the overdrive cut-in speed. Nevertheless, the reliability of the unit has been proved in service.

Automatic transmissions

It seems fairly certain that a number of manufacturers in this country will shortly offer automatic transmission as an optional extra. In America, the proportion of sales of vehicles incorporating such transmissions is so high that any manufacturer who does not offer such an option will find it progressively more and more difficult to sell his products, not only in the U.S.A., but also in markets to which American cars have relatively free access. This was no doubt partly responsible for the decision by Rolls-Royce and Bentley to offer the Hydramatic transmission, first as an extra, and now as a standard item on their cars, and also for Jaguar to offer the Borg-Warner automatic transmission as an optional extra.

The Hydramatic transmission is well known. It consists of an epicyclic gearbox giving four forward speeds and one reverse, and a fluid flywheel which transmits only part of the engine torque, so losses due to slip, which in any case are not large in a private car, are minimized. This unit is now being made over here, and considerable development work has been done on it by Rolls-Royce and Bentley. The latest models are said to be improved in a number of respects as compared with earlier ones.

This unit has a mechanical efficiency comparable with that of a normal transmission. The choice of ratios is restricted by the arrangement of the gear trains, as are all epicyclic gearboxes. Since the ratios adopted differ from those previously offered in the synchromesh gearbox, where no such limitations existed and where, therefore, the ratios were presumably chosen specially to suit the characteristics of the chassis, it is possible that the ratios in the automatic transmission are not ideal. The effect of slight differences in ratio of this kind can be minimized if the engine torque curve is of the right shape, and this undoubtedly has not escaped the attention of the Rolls-Royce development engineers. In any case, so far as acceleration alone is concerned, any slight loss due to ratios slightly different from the ideal can be more than compensated for by reduced times of gear changes and by the fact that changes are made under power.

The Austin Princess is also fitted now with an automatic transmission incorporating a fluid flywheel and four-speed epicyclic gearbox. Probably this transmission is of a similar type to that fitted to the Rolls-Royce and Bentley and available also as an extra in the Armstrong Siddeley Sapphire.

Hydrodynamic torque converters can be designed for maximum efficiency at only one speed and one torque ratio. Losses at other torque ratios and speeds can be reduced by limiting the torque range of the converter, and also by various design features on the blades and other parts of the converter, some of which do not suit American methods of production. There has been a noticeable tendency in America to restrict the converter torque range and increase the number of speeds in the associated epicyclic gearbox to retain the same overall torque ratio in the transmission.

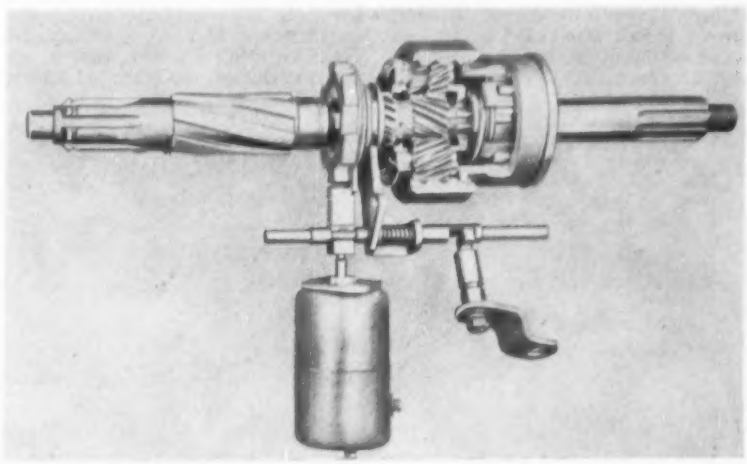
The setting up by Borg-Warner of manufacturing facilities in this country has made it possible for Jaguar to offer this automatic transmission as an optional extra on the Mark VII type M for the home market. These cars for the American market have been available with this equipment for some time. It is significant that the converter has a torque ratio of only 2·0 : 1, and that a three-speed box, giving ratios of 1·0 : 1, 1·4 : 1, and 2·3 : 1, is used in conjunction with it.

To obtain extra over-run braking from the engine, a lower gear must be engaged manually in the normal way. There is nothing to prevent this being done at any speed, though the design of the box would minimize shock if engagement were attempted at too high a speed, and therefore would give the driver time to reconsider his action. This has been done deliberately by the Borg-Warner engineers, who concede to the driver at least some measure of intelligence.

It is well known that the hydrodynamic torque converter must be matched to the engine in such a way that the engine speed is restricted to the maximum torque speed during conversion, even if the throttle is fully open. This has the effect of taking away the top of the tractive effort curve in each of the gears, but the amount lost in this way is reduced by the torque conversion, as compared with a normal stepped ratio box. At full throttle acceleration, the engine runs up to approximately the maximum power speed with the converter acting as a fluid flywheel, so the upper part of the tractive effort curve in each gear is what it would be with a normal box. Furthermore, in direct drive, above the operational speed range of the torque converter, the hydrodynamic drive is locked by a mechanical clutch.

Hobbs transmission

The only British automatic transmission at present available is the Hobbs unit, which is fitted to the Lanchester Sprite. During the past year, Hobbs Transmission Ltd. has become a part of the B.S.A. organiza-



The Borg-Warner overdrive unit, sectioned to show the epicyclic gear train, the teeth for locking the sun wheel to the planet carrier, the dog teeth, pawl and baulk ring

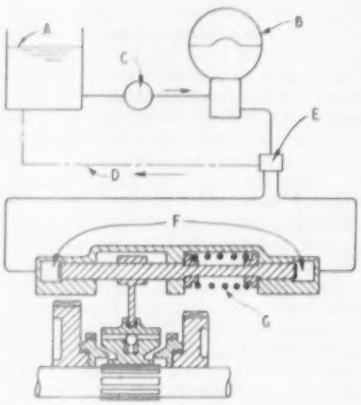
tion, but there appears to be no basic change in the transmission. This unit comprises two main sections: the gear train which occupies only a small part of the bulk of the unit, and the clutches and brakes which, by holding various components either to the input shaft or to the case, provide the ratios desired.

The gearing consists of four sun wheels, four compound planets in two groups of two, each meshing together, and a planet carrier. Of the four sun wheels, the first can be locked to the casing by one of the brakes, the second can be locked either by a brake to the casing, or by a clutch to the input shaft from the engine, the third may be clutched to the engine, and the fourth is permanently connected to the output shaft.

Each group of two planets comprises one with two rows of teeth and another with three rows. The front row of teeth on the double-planet meshes with the third sun wheel; the rear row of teeth on this planet meshes with the fourth sun wheel, and thus is con-connected to the output shaft. On the triple-planet, the rear row of teeth meshes with the front row on the double-planet. The other two rows of teeth mesh with the second and first sun wheels.

To obtain first gear, the planet carrier is held by the rear brake, each of the double-planets then acts as a very short layshaft, similar to a lathe back gear, and gives the desired reduction. The triple-planet rotates in the opposite direction to the double-planet; it follows therefore, that if the planet carrier is stationary, the first and second sun wheels are driven round in the reverse direction to the third sun wheel. Sun wheel number one runs in reverse at a lower speed than sun wheel number two. If, therefore, sun wheel number three is driven, but the first sun wheel is locked, the planet carrier is driven forward at the same rate as that at which the first sun wheel was previously driven backwards. This imparts a higher velocity to the output shaft and gives a second speed. By locking sun wheel number two, instead of number one, a higher forward speed is obtained at the output shaft and third gear is obtained.

By clutching both the second and third sun wheels to the engine, the gear trains are locked and direct, top, gear is obtained. Reverse is selected by braking the planet carrier and driving the second sun wheel. This then drives the triple-planet, which in turn drives through the double one to the output shaft but, of course, in the opposite direction as compared with first gear.



A Reservoir
B Main accumulator
C High pressure pump
D Return
E Selector valve
F Selector rod control cylinders
G Return spring

Diagram of the hydraulic circuit for gear selection on the Citroën DS19

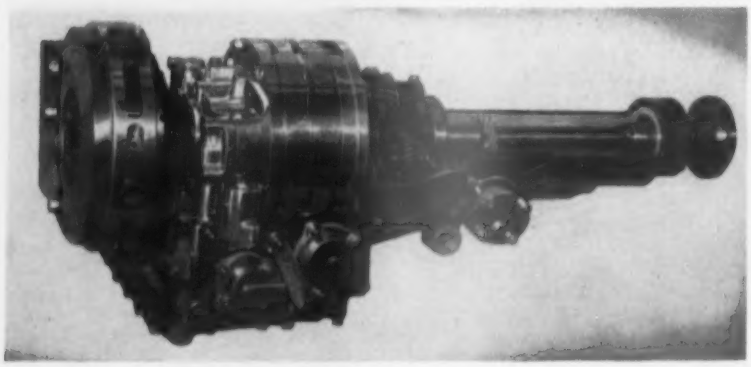
In all forward speeds, the front clutch is engaged and drives the third sun wheel. Also, the rear brake is engaged when first gear is in operation; in second gear the middle brake, and in third the front brake are engaged, while in reverse, the rear clutch and the rear brake are engaged.

Each change, therefore, involves freeing one brake or clutch and engaging another. To effect smooth changes with this box depends on two things. First, for drive changes, that is, all upward changes and the kickdown change to third, the timing of the freeing of one clutch or brake and the take-up of the other must be so synchronized that there is neither a break in the drive nor any tendency on the part of both to drive together too strongly. Second, for over-run changes, the torque capacity must be limited sufficiently to avoid too rapid a change in engine speed; at the same time, the first requirement already stated above must be satisfied. The take-up from rest must be smooth and must not only take place at the correct engine speed but also must not be spread over too great a range of speed.

To obtain a smooth change in the drive condition, it is also essential not to have too great a surplus of torque capacity in the brakes and clutches. This problem has been solved by making the oil pressure in the clutch and brake operating system responsive to throttle opening. With the throttle fully closed, a very low pressure is required, about 20 lb/in^2; during the first part of throttle opening this pressure must be approximately doubled. Since the movement of the accelerator pedal would normally have to provide the extra spring-load needed on the relief valve, operation might be too heavy. To avoid this, servo assistance from the oil pressure has been brought in to provide the major part of the extra load. From the "just open" to the "fully open" throttle positions, there is a further progressive rise of oil pressure with throttle opening; the full throttle pressure is about 60 lb/in^2, or even more. Engagement of the clutch, for take-up, is controlled by a valve that is pushed inwards by oil pressure and outwards by centrifugal force. Precautions are taken to avoid too rapid a take-up when the oil is warm, and too slow an engagement when it is cold. The rate of release of the brakes and clutches is controlled by venting the oil from a capacity cylinder through a restriction.

Obviously a great deal of thought and development work have been devoted to the various aspects of the operation of the gearbox and recently considerable improvement has certainly been made in its functioning and smoothness of operation. This unit provides what is essential in an automatic transmission for a small or medium car of the horsepower and weight relationship obtaining in many British and Continental cars. Its mechanical efficiency is of the same order as that of a normal step gearbox, and neither the cost of manufacture nor the weight are too different from conventional types of transmission.

With the Hobbs transmission, the control lever has six positions: reverse, neutral, first, second, third and automatic. The position selected determines the highest gear obtained, so that extra over-run braking is available when required. Furthermore, the unit can be held in a suitable gear, third speed, for instance, for overtaking at speeds at which it would normally be in top



In the Hobbs transmission, the gear train occupies only a small part of the bulk of the unit

gear. In these circumstances, third gear, of course, can also be obtained by employing the kickdown arrangement provided. However, it can be annoying to have to do this time and time again, in attempting to pass another vehicle, when each time it is subsequently found impossible to do so. A safeguard is provided so that if the lever is moved to any gear position for which the road speed is too high, the gear will not be engaged until the speed has dropped sufficiently. First gear can only be engaged by moving the lever to the appropriate position.

When the lever is in the "automatic" position, starting from rest is effected in second gear, and upward changes are made at speeds depending on the throttle position—the wider open the throttle the higher the speeds for upward changes. This is similar to the arrangement found on many other automatic gearboxes. However, the Hobbs unit in the Lanchester Sprite differs from others in that once the car is in top gear, normal depression of the accelerator pedal does not produce downward changes, even though the road speed is low enough for the transmission still to be in a lower gear for accelerating at that throttle opening. In such circumstances, a shift from top into third gear, for instance, can only be obtained by using the kickdown change, or by using the lever and moving it to "3." The more usual change speed arrangement can be provided if desired, but Hobbs Transmissions Ltd. feel that the arrangement on the Sprite is less fussy.

Noise has not been a problem with the Hobbs transmission, partly because the gear tooth speeds are not high and partly because the support for the shafts is rigid. It is interesting that the teeth of the gears are cut, by shaping, without any subsequent shaving. The tooth relationship in the compound planets is, of course, critical in order to share the load between the two groups of planets, and indeed to make assembly possible. In the case of the double-planet, both rows of teeth could be cut simultaneously since their helixes apparently are identical so far as direction and angle are concerned. In the triple-planet, the three rows cannot be cut together, but at least two could be. It has been found necessary to provide locating holes to serve both for machining and for assembly. With certain combinations of tooth numbers, assembly in incorrect positions is possible, whereas with others it is not.

The choice of forward ratios is not limited by the gear train arrangement, as it is with some of the other epicyclic arrangements. The only limitation is in obtaining a reasonable reverse ratio with certain forward speeds, but this does not apply in the normal range of gear ratios. As usual, two oil pumps are provided, driven one from each end of the gearbox. Thus, the vehicle can be tow-started.

Synchromesh gearboxes

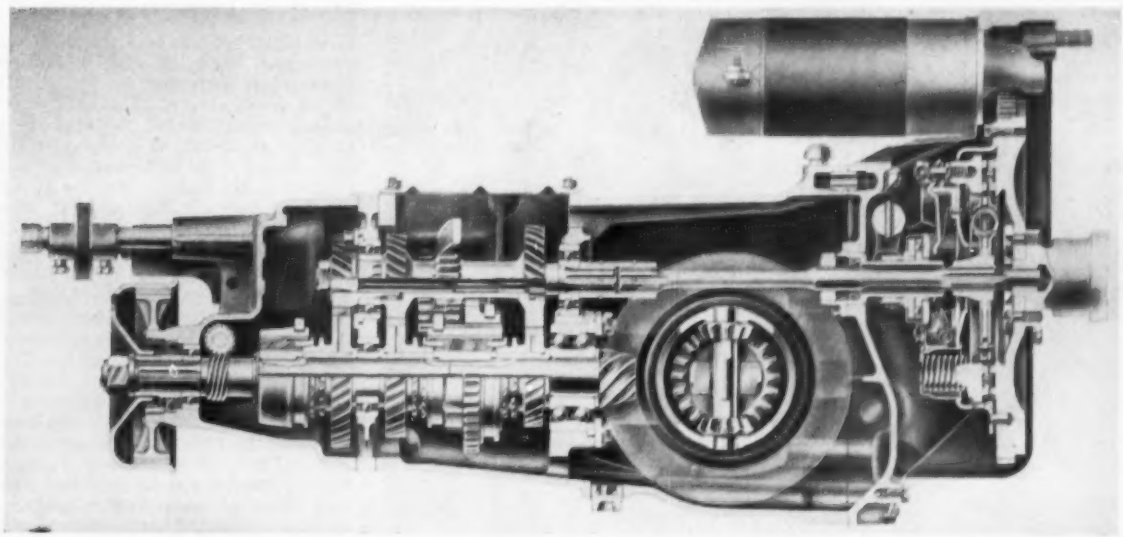
The new Citroën DS19 has an unconventional, four-speed synchromesh gearbox. As on the previous model, the drive is indirect in all gears; each speed is obtained by means of one pair of gears and the input and output shafts are side by side. The interesting feature of the gearbox is the use of a hydraulic system to change gear and actuate the clutch, in a manner not unlike that of the Manumatic system. All the driver has to do is to move the gear shift lever. The selector rods are moved by the hydraulic pressure on their ends. It will be interesting to see in due course more details of the mechanism by means of which these results are obtained.

A manual control, mounted on the dash, is incorporated to release the pressure in the hydraulic circuit for disengaging the clutch. When this is actuated, the clutch is held in the engaged position by its presser springs. This device is incorporated so that the starter handle can be used to turn the engine, and to enable the vehicle to be tow-started. The clutch is engaged automatically for starting from rest, so there is no clutch pedal.

Another new synchromesh gearbox, about which more information is available, is that on the Fiat 600. The engine, gearbox and final drive are all in one unit at the rear of the vehicle, with the final drive between the engine and gearbox. To suit this arrangement, the input and output shafts are side by side and all the gears are indirect. One pair of gears only is used for each ratio. The pinion shaft of the final drive unit is, in fact, extended to form the gearbox output shaft.

This is an interesting design. Although four speeds are incorporated, the lengths of the shafts between bearings is no greater than would be needed for a three-speed synchromesh unit. The second speed gear train is overhung, on the rear of the shafts, as close as possible to the centre bearing of the three-bearing output shaft. Borg-Warner baulk type synchromesh is used for the three top ratios. The first speed gear on the output shaft is carried on the outside of the synchromesh sleeve for third and top speeds, in the manner of a number of three-speed boxes, for example, the Vauxhall unit. Reverse is provided for by a double-pinion on a separate shaft. This pinion is slid axially to mesh with the first speed gears on the input and output shafts.

The arrangement for selection to give a normal gear gate is interesting. Three selector rods are employed; one engages reverse, as already mentioned. To engage first speed it is necessary to move the first speed gear forwards, whereas second speed is obtained by moving the sleeve towards the rear.

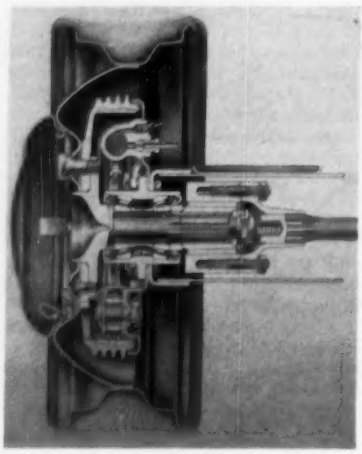


A noteworthy feature of the Fiat 600 gearbox is the close spacing between the bearings that carry the gears

The forks for both the first speed gear and the second speed sleeve are therefore mounted on one selector rod, so that each has a dead, reverse direction movement. Third and top speeds are obtained by shifting the third rod to actuate the sleeve in the normal way.

The clutch housing, which is open at the bottom, forms the rear wall of the final drive casing. It has a pressed cover on top to complete the enclosure of the clutch and flywheel. The gearbox and final drive casings are combined, and an intermediate wall supports bearings that carry the rear ends of the input and the output shafts. Another wall, housing the bearings that carry the front of the input shaft and the centre of the output shaft, is incorporated forward of that which separates the final drive unit and the rear portion of the gearbox. In front of this wall is an extension casting that houses the second speed gear pair, the speedometer drive and the striker unit; it also carries the hand-brake mechanism and drum. A bearing in the front end of the extension casting affords additional support for the output shaft. A lubricant, of EP 90 type, is used for both the gearbox and final drive. It is interesting to note that the bushes on the pinion shaft, on which the second, third and top speed gears run, are of case-hardened steel, as are also the selector forks.

During assembly, first the pinion shaft and the adjacent bearing are fitted in the gearbox. Then the top and third speed gears and synchromesh mechanism and the first speed gear are fitted on to this shaft. Next, the input shaft cluster, reverse pinion and their respective shafts and bearings are added. The next operation is the assembly of the front wall of the box, together with its bearings, the selector shafts and forks, the second speed gears and synchromesh mechanism, the speedometer drive gear. Finally the front cover is fitted. The whole design gives evidence of careful thought and is neat and compact.



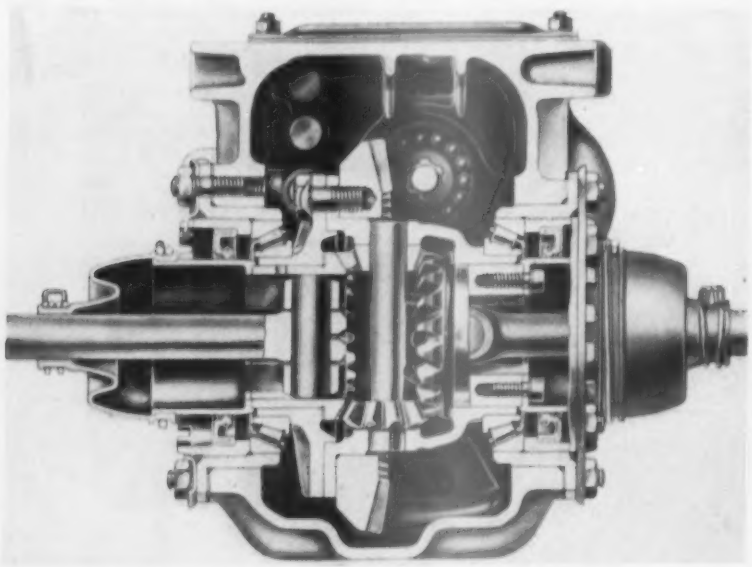
A rubber-sleeved coupling connects the half shaft to the stub axle of the Fiat 600 rear-engined vehicle

FINAL DRIVE UNITS

Little Change in Axle Design

BECAUSE it showed a significant departure from conventional practice, the final drive unit for the Fiat 600 is of great interest. As mentioned in the transmission section of this review, the engine, final drive and gearbox are combined in one unit, with the final drive between the clutch and the gearbox. Therefore, the shaft connecting the clutch and the gearbox input shaft is above the differential, and passes through the final drive casing. The spiral bevel pinion shaft is extended to form the gearbox output shaft and is supported, immediately adjacent to the pinion, on a double-row angular contact ball bearing, with a shim, or ground washer, for adjustment of its axial location.

The casing for the simple two-pinion differential is in two parts, one of which is the end cover. Both are flanged and are spigoted together and secured to the crown wheel by set screws. The crown wheel overlaps the ends of the differential pinion spindle which it thus locates. Two taper roller bearings carry the crown wheel and differential assembly. Ring nuts retain their outer races and provide for adjustment to the meshing of the crown wheel and pinion and for setting the pre-load. The housings for these bearings are flanged and fit in flanged holes in the side of the final drive casing.



In the Fiat 600 final drive unit, the differential pinion spindle is axially located by the crown wheel

Since the differential cage and crown wheel assembly is short, it is assembled in from the open end of the casing. Then, the bearing and seal housings are placed in position to locate the unit. The differential gears have large diameter bosses within which are block type universal joints. Eyes for the pins of the joints are formed on the inner ends of the axle shafts. These joints accommodate only the universal movement, since the rear suspension geometry is such that the half shafts do not move axially. The lip type oil seals on each side of the final drive casing bear on flanged sleeves spigoted on to bosses of the differential gears and secured by set screws. Rubber gaiters are fitted over the outer ends of these sleeves and are clamped to the half shafts. Adjustment of the meshing of the crown wheel can be carried out without any dismantling of the unit.

The wheel-assembly on each side of the rear suspension is mounted on a fabricated pressed steel V-link. Two taper roller bearings carry the hub shaft. They are in a flanged tubular housing bolted, together with the brake shoe carrier plate, to the suspension link. The hub shaft has a flange formed integrally at its outer end. On this flange the brake drum is spigoted, and the road wheel is also secured to it by set screws passed through the drum.

On the splined inner end of the hub

shaft is a flexible coupling, comprising a star-shaped, or toothed, inner component in a similarly shaped outer sleeve, with rubber between the two. The outer sleeve is splined on to the adjacent end of the half shaft. This coupling absorbs vibration and locates the half shaft.

The final drive assembly of the new Citroën DS19 is said to be basically similar to that used on the previous model. At the hub ends of the axle, there are redesigned, constant velocity, double Hooke's type universal joints to accommodate a lock angle of 45 deg. This gives a much smaller turning circle than before.

With regard to the more conventional rear axles, the new Armstrong Siddeley 234 and 236 are equipped with the Salisbury 3HA hypoid unit. The Salisbury 3HA rear axle of the Jaguar 2·4 litre model is conventional; only the suspension is unusual. The Peugeot 403, continuing the tradition of this make, has a worm drive rear axle similar to that of the 203.

It is interesting to note that none of the cars with integral engine, gearbox and final drive units has a hypoid right angle drive pair. The need for hypoid offset is eliminated by using the all-indirect step gearbox with the input and output shafts side-by-side. The other virtue of the hypoid arrangement, that is, the stronger pinion obtainable when high final drive ratios are used, is not required with this type of gearbox, since a suitable final drive ratio can be obtained by appropriate choice of ratios in the gearbox. Apart from these applications of spiral bevel units, the only new car with this type of final drive gear is the Sunbeam Rapier, and this axle is not a new design.

REAR SUSPENSION

More European Cars Have Independent Suspension on all Four Wheels

IN all countries, suspension design has been largely influenced by the condition of the roads in the home market. However, since the war, the motor industry has expanded to such an extent that most manufacturers, particularly in Europe, are seeking to find an outlet for their products in export markets, where the demand is steadily increasing. Since road conditions in markets where motor vehicles are not manufactured on a large scale are generally very poor, it is becoming increasingly obvious that suspension systems must be improved. In fact, the introduction during the last few years of many new independent and other improved rear suspension systems is a sign that developments in this respect are well advanced.

An interesting four-wheel independent suspension is that of the new Citroën DS19, which embodies a hydro-pneumatic spring unit for each wheel. The design is ingenious, but complex by comparison with the conventional types of suspension. However, complexity might be justified if ride and high-speed road-holding qualities are markedly improved, particularly when road conditions demand something better than the conventional suspension layout. Details of the design of this type of suspension were published in the August, 1955, issue of *Automobile Engineer*. It is interesting to speculate as to the reason for the introduction of some of the unusual features which, according to road test reports, give excellent results and fulfil the makers' claims.

Briefly, the rear suspension is based on two trailing arms, which carry the wheels. Each arm is linked to a piston, which therefore reciprocates in its cylinder as the wheels deflect up and down. The cylinder is charged with fluid under pressure. Normally, pressurization is effected by an engine-driven hydraulic pump, but when this pump is inoperative, it is maintained by a hydraulic accumulator. A distributor valve directs the hydraulic fluid under pressure either into the accumulator to recharge it, or into the suspension system.

When the piston reciprocates, the fluid is passed backwards and forwards through two-way restrictor valves, which act as dampers. The spring is a sealed pneumatic unit at the end of the cylinder; thus, the damper valves are between the spring and the piston. This spring takes the form of a sphere which is bisected by a flexible diaphragm that separates the gas from the liquid.

An anti-roll bar connects the two trailing arms. Mounted on this bar, mid-way between its ends, is a tongue that actuates a slide valve for static height correction. This valve is incorporated in the circuit between a manually-controlled isolation cock, which normally is open, and the hydro-pneumatic spring unit. When the arms rise, the slide uncovers the delivery port in the valve unit and hydraulic fluid passes under pressure into the hydro-pneumatic spring cylinders; when the arms fall again, the delivery port is closed and a return port opened so the fluid passes from the spring units back to the reservoir. So long as the suspension remains at the normal height, both the delivery and return ports are closed.

The trailing arm type of rear suspension gives a low roll axis. However, the reduction in roll resistance due to this has been compensated for by the anti-roll bar. An advantage of suspension systems of this layout is that the wheel axes always remain perpendicular to the longitudinal axis of the vehicle so there is no roll steering effect at the rear wheels, such as is obtained with a Hotchkiss drive. This tends to give good directional stability. The trailing arm arrangement is probably the lightest form of independent suspension. Moreover, because of the low unsprung weight obtainable, there is a tendency for a better contact between the wheel and the road to be maintained. In other words, there is less tendency for adhesion to be reduced either by wheel-hop on rough ground or during braking. With compressed gas suspension systems, the rate increases with the deflection. This also tends to reduce wheel-hop.

At first sight, the incorporation of an automatic height corrector on a passenger car may appear to be superfluous. However, this is not so when a low suspension rate is adopted. Because of the relatively large deflections of the wheels from the bump to rebound positions, together with the relatively large difference in height as between the laden and unladen conditions, the

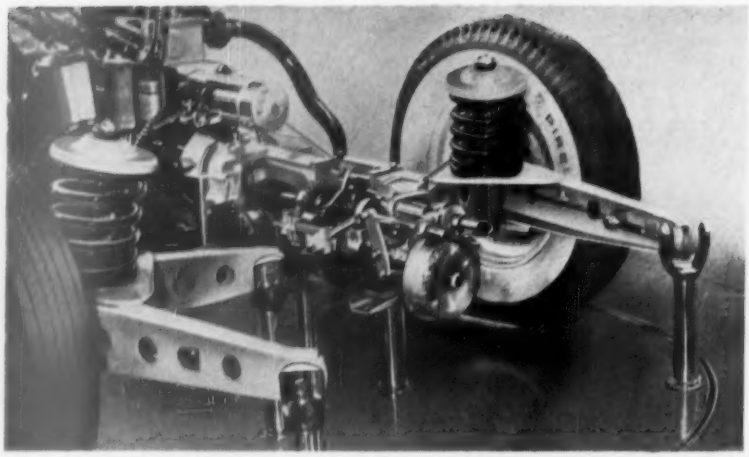
An outstanding feature of the independent rear suspension of the A.C. Ace chassis is its simplicity

ground clearance in the unladen condition would have to be excessive for the clearance in the laden condition to be adequate. Thus, the height corrector valve enables a constant ground clearance to be maintained regardless of load, and therefore enables the designer to keep the floor level low. This reduces the overall height of the vehicle and also the height of the centre of gravity, with beneficial effects on stability.

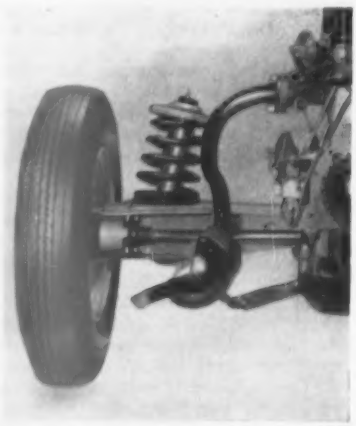
Another noteworthy feature of this vehicle is the extreme rigidity of the structure to which the suspension unit is attached. This has a marked effect on the road-holding qualities of the vehicle. For, if the frame on which the suspension is attached is flexible, the wheels can deflect without the dampers operating. This gives the same effect as an undamped spring.

It is interesting to note that the new 2·4 litre Jaguar is fitted with cantilever springs at the rear. This manufacturer is one of the few in this country to depart from the conventional semi-elliptic spring layout. The cantilever type of rear suspension was more widely used many years ago, particularly for the more expensive types of car, but it never became universally accepted, since it does not give the same degree of lateral stability as the semi-elliptic spring. However, on the Jaguar vehicle, this disadvantage has been overcome by fitting a Panhard rod.

Apparently, this design has been chosen because it obviates the need for stress-carrying members at the rear end of the car, which is only called upon to carry the load imposed by the luggage. Moreover, it enables a longer wheelbase to be adopted for a given overall length of vehicle. With this arrangement, isolation of the spring from the frame, by the use of rubber, is relatively easy.



On the Fiat 600 rear suspension, the axes of the pivots of the links are in line with the centres of the universal joints



Fiat suspension viewed from the rear

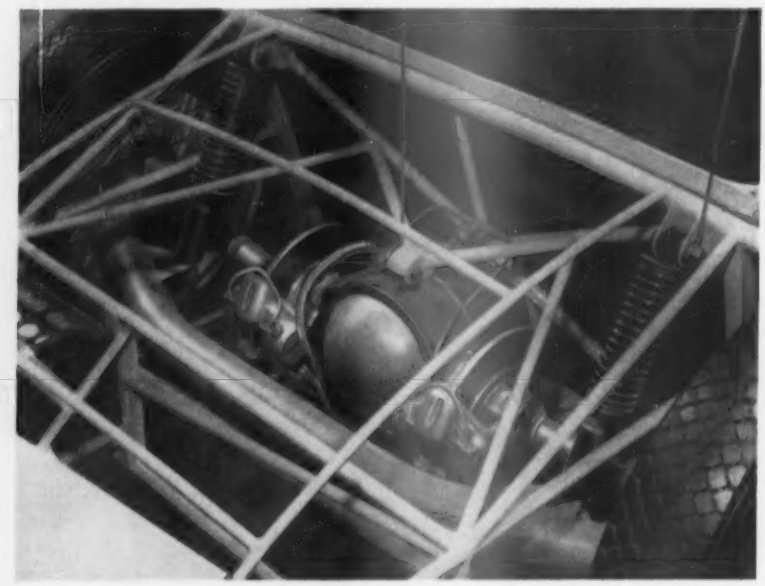
The spring on each side is housed in the rear end of a longitudinal, box section member. At its centre it is bolted between the end plates of two rubber-to-metal bonded sandwich components. The outer plates of these sandwich units are bolted to the frame. A rubber bushed pin secures the trailing end of the spring to a bracket under the end of the axle. The other end of the spring bears on a rubber pad on the frame.

This spring forms the lower of the two arms that react the brake and drive torque. The upper arm is rubber bushed at each end. Its rear end is attached to a bracket on top of the axle and its front end is pivoted on a cross member behind the rear seat.

The Fiat 600 model has a type of independent rear suspension that is uncommon in Britain, although a similar layout was introduced in this country many years ago by Lagonda Ltd., and is still used on their 3 litre model. In the Fiat car, each wheel is mounted independently on a semi-trailing arm, of V-form. The axes of the pivots at the ends of the arms of each V-link are in line at an angle to the longitudinal axis of the vehicle and they pass through the centre of the universal joint at the inner end of the half shaft. Near the wheel hub, a coil spring seats on the V-link. Since the car is of the rear-engine layout, it has an inherent tendency to undesirable oversteering characteristics which, however, this suspension has been designed to counteract.

In the Riley Pathfinder, special attention has been given to the design of the suspension to make the car roadworthy at speeds in the region of 100 m.p.h. The chassis frame, which is an important component so far as suspension characteristics are concerned, is a completely new design. It has box section side members which, the manufacturers state, give vastly improved road-holding, steering and driving characteristics.

The movement of the rear axle is



A de Dion rear suspension layout has been adopted on the Lotus chassis

controlled by two pressed steel arms, pivoted near the centre of a cross member forward of the axle. These arms, which react brake and drive torque, are attached to the axle close to the wheel hubs, and are insulated from vibration by rubber in a channel section carrier plate. A coil spring is interposed between the rear end of each torque arm and the chassis frame. The telescopic dampers are finned at their lower ends to dissipate heat rapidly, and are carried concentrically in the springs. An anti-roll bar is incorporated; this, together with the wide spacing of the coil springs, gives the chassis good stability.

On the new Sunbeam Rapier, the rear suspension is of the conventional semi-elliptic spring type shackled at the rear end. To reduce noise transmission, rubber bushes are fitted in the spring eyes, and the axle casing is insulated from the springs by rubber pads. An additional leaf is fitted at the bottom of the spring. This comes into operation as the wheel rises, and so gives an increasing rate as the deflection becomes greater. It is surprising that dual-rate or even triple-rate springs are not used more; they have the advantage of giving greater uniformity of the riding characteristics under various load conditions. The Simca 1300 also has two additional leaves of equal length on the bottom of each rear spring. These, in addition to giving a dual-rate, also assist in taking some of the brake torque load, and thus reduce the axle wind-up.

Torsion bar suspension is now used on the Packard. There are two straight manganese steel bars, approximately 9 ft long and nearly 1 in diameter,

Two extra spring blades of heavy section are fitted below the rear springs of the Simca Aronde 1300

one on each side of the chassis frame. They extend from front to rear to interconnect the front and rear suspension units. The arms at each end of each bar are at 180 deg to one another and their outer ends are connected to the suspension units. Thus, if a bump deflects the front wheels upwards, the resulting torsional deflection of the bar increases the downward loading on the rear suspension arms.

An automatic levelling system, or compensator, is also incorporated. The function of the compensator is to maintain the body at a constant height and on an even keel, regardless of load. Two additional torsion bars, about 4 ft long, are installed parallel to the main bars. They are fastened at one end to the rear arms of the main torsion bars, and at the other end to an actuator lever and compensator reversible D.C. motor. This motor automatically levels the car body by twisting the compensator torsion bars in the appropriate direction and by the correct amount. The direction and duration of rotation of the motor are controlled by a switch connected to a lever rigidly attached to the main torsion bar on the left-hand side of the vehicle. A 6 sec delay prevents the leveller from working when a car hits a bump. Also, a switch on the brake pedal opens the circuit to the actuator motor to prevent operation while the brakes are applied. A *flat-tyre* switch under the dash can be used to cut out the leveller when the car is being jacked up.

The Lotus Mk IV sports-racing car has been very successful in competitions and has gained a good reputation for its road-holding qualities. Therefore, it is of interest to study the design of the suspension. The front independent suspension is of the swing axle type and is commented on elsewhere in this review. A de Dion type layout has been adopted at the rear. Long coil springs are fitted and are mounted near the outer ends of the tubular axle. The springs slope forward and their upper ends are attached to the frame, which is of tubular construction. The telescopic dampers are mounted coaxially with the coil springs, to form a compact installation.

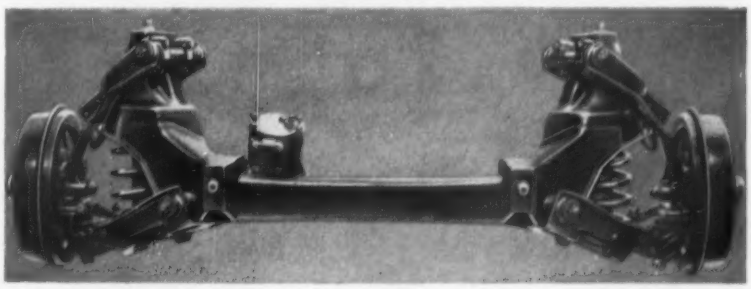
FRONT SUSPENSION

More Widespread Employment of Rubber to Eliminate Lubrication Points and Isolate Vibration

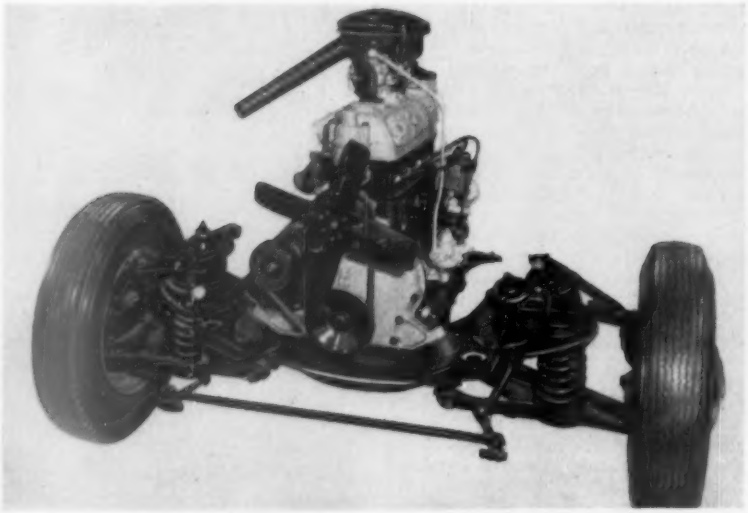
THERE is a marked trend towards grouping the front suspension, steering gear and dampers together on a pressed steel cradle, or cross member, to form a separate assembly that is rubber-mounted on the chassis. It has been found that by this means much of the noise from the road wheels can be isolated from the body. The Standard Vanguard III is a good example of this type of construction. This vehicle has a self-contained, suspension sub-assembly attached by four bolts to the body extension members. The axes of the forward pair of bolts are horizontal. These bolts are carried in rubber bushes mounted with their axes parallel to those of the wheels. At the rear, the other two bolts are vertical and secure the assembly to conical-shaped rubber mouldings.

This front suspension incorporates the conventional upper and lower wishbone arm arrangement. A coil spring seats on the lower arm and bears against the pressed steel pan on the front cross member. The telescopic dampers are mounted coaxially with the springs. This layout gives a very clean design, but from a heat dissipation point of view, it cannot be as good as those incorporating double-cylinder lever arm type dampers, not only because of the enclosure of the telescopic dampers by the springs, but also because of the rubber insulation at their ends.

For two reasons, rubber components

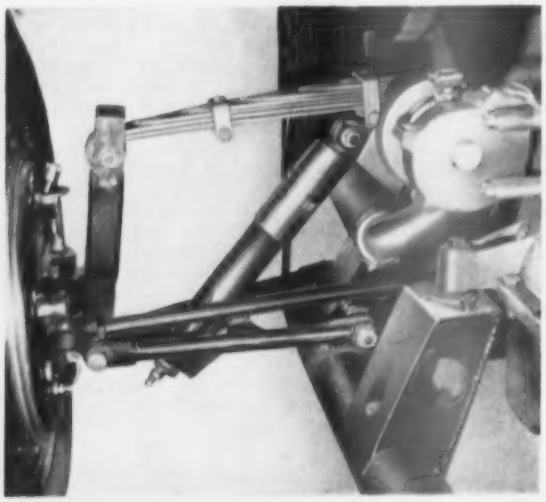


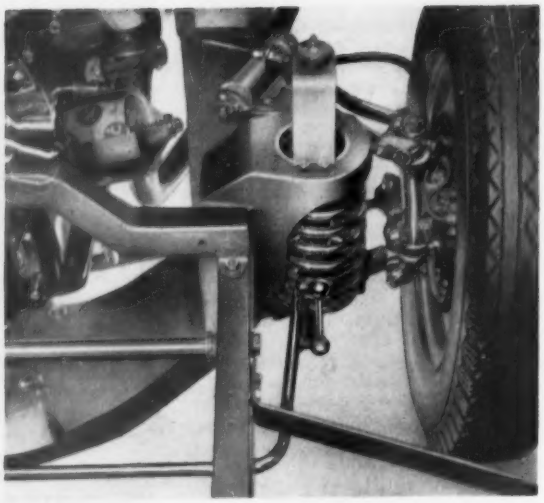
The Jaguar front suspension and steering assemblies are on a cross member that is rubber-mounted under the vehicle structure

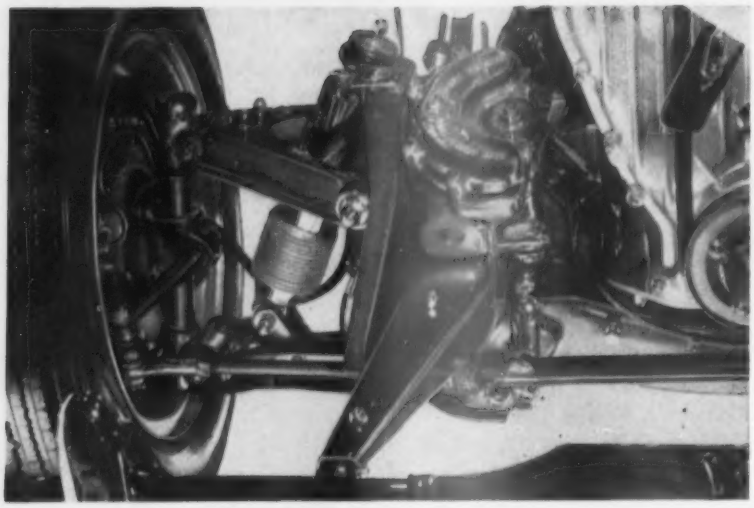


Right: A compact front end assembly, incorporating double transverse wishbone link type suspension units, is employed on the Borgward 1½ litre model

Below: A number of components of the front suspension of the A.C. 2 litre chassis are identical with those employed at the rear

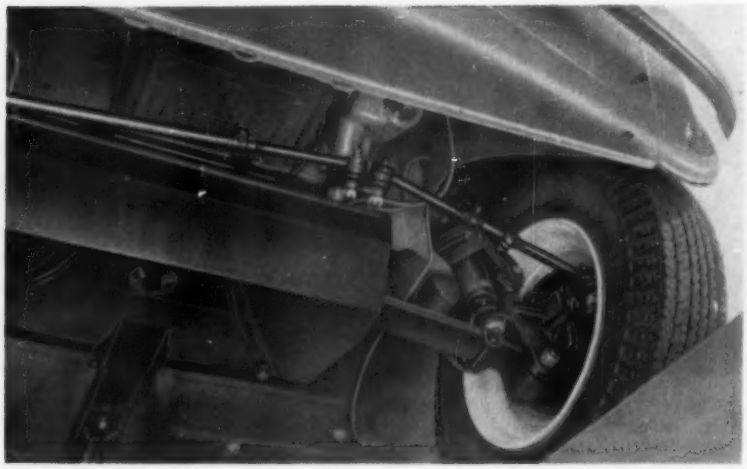






Above: In the Singer Hunter 75, a simple mounting arrangement is employed to carry the shock absorber coaxially with the coil spring of the front suspension

Left: The upper links of the front suspension of the Riley Pathfinder are of the wishbone type, while, at the bottom, a single transverse arm and a drag strut are employed on each side



On the Fiat 600, a baffle plate screens the semi-elliptic transverse leaf spring and its mountings from water and mud splashed off the road

are being increasingly used in motor cars. One is that they isolate and damp out vibrations and the other is that, if they are used instead of metal bearings, lubrication points are eliminated. The new 2·4 litre Jaguar is an example of this widespread application of rubber, particularly in the suspension assembly, which also embodies the steering gear and linkage. In this application a Burman steering box is employed in conjunction with a three-piece track rod. Rubber bushes are used at each end of the centre section of the track rod, in the front anti-roll bar mountings, and for the pivot bearings at the inner ends of the wishbones. This has reduced the hand lubrication points to nine.

The mounting of this assembly on the main structure has obviously been very thoroughly studied. It is, of course, important that the unit should be held rigidly in the plane of steering and yet give limited flexibility in other directions. To meet these requirements, vertical and transverse loads are transmitted by bonded rubber blocks above the axis of the wheels. These blocks seat in indentations in the cross member. Fore and aft movement is controlled by forward extending torque-reaction arms, the ends of which are rubber-mounted on the frame.

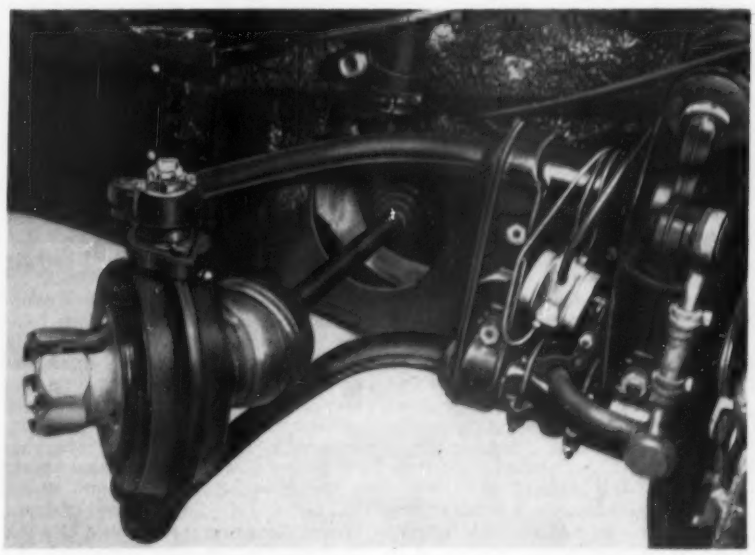
One of the simplest, most inexpensive, and yet effective, front suspension systems seen at the Show was that of the Fiat 600. Rubber bushed bearings are employed at both ends of the upper wishbone arms. The lower arms are formed by the transverse semi-elliptic leaf spring, which is supported at two points in rubber mouldings. These supports are arranged so as to act, in effect, as the pivots of the lower arms of the suspension unit. In fact, they are one of the most interesting features of the system. The top spring leaf is arched locally at each end, where a thick rubber moulding, in two pieces, embraces the spring to secure it to the structure. This moulding is housed in a bracket split in a manner similar to a bearing housing. As viewed from the front or rear, its inner faces are curved to allow the spring to deflect freely on each side of the bracket, while the front and rear ends of the rubber are so shaped as to resist in compression fore and aft movement of the spring.

The steering gear is also simple and a divided track rod system has been adopted. The track rods are of different length, so the geometry of the linkage system is not quite correct, but the difference is so small that it should not be noticed by the driver.

A noteworthy feature of the front suspension of the Citroën DS19 is the simplicity of the layout of its suspension arms. On each side, two forged arms are employed, one above the other. The pivot bearings are formed at the inner ends of these arms and are parallel to the longitudinal axis of the car. As these arms extend forwards, they are swept outwards and thus form transverse links. In effect, this is the same as an orthodox wishbone system, except that the two arms are approximately of equal length. This geometry is unusual, since it tends to introduce tyre scrub. A lever attached to the rear end of each upper link actuates the hydro-pneumatic spring which, in principle, is the same as that described elsewhere in this issue, in the review of the rear suspension systems. From this lever, a drop-link is attached to the anti-roll bar, which actuates the static-height corrector valve.

The front and rear independent suspension of the A.C., 2 litre chassis is a good example of a simple design with many common components, and undoubtedly is economical to produce. The layouts of the front and rear suspension systems are similar. Each comprises a transverse leaf spring attached at its centre to the chassis, and linked at each end to the upper, king-pin bearings. A wishbone type lower link is employed at each side. It is of fabricated tubular construction and is at a level close to the axis of the wheel. Since the spring is placed some distance above the wheel centre, the drag, brake torque and side thrust loads imposed on it are relatively light. The lower arm takes most of the side thrust and drag.

Designed primarily for motor racing, the suspension of the Lotus Mk IV chassis has been specially considered in relation to road-holding and directional stability. The front suspension linkage comprises two long transverse arms, one on each side, pivoted near the centre of the frame cross member, and a long radius rod on each side

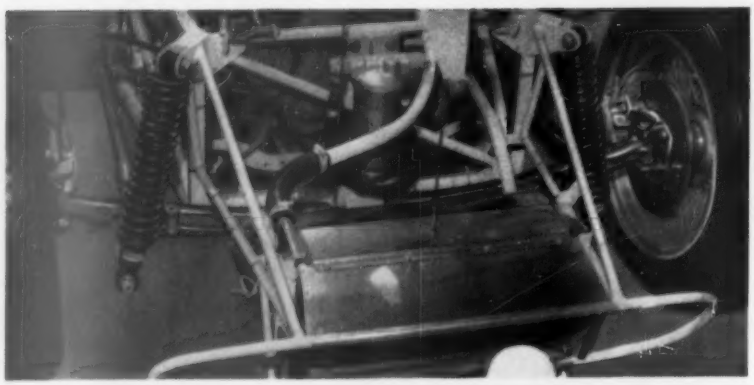


The upper link of the Citroën front suspension is connected by a lever to the hydro-pneumatic spring and by a drop link to the anti-roll bar

pivoted just forward of the toeboard. At the outer end of each transverse link is a boss that carries the swivel pin. The radius rods, which react brake torque and drag, are connected to the transverse links immediately behind the spring and coaxial shock absorber assemblies. These assemblies are attached at their lower ends to brackets bolted to the front face of the transverse links. Their upper ends are bolted to nodes on the space frame of the chassis. The spring seating pans are attached to the telescopic shock absorber casing and ram, so that the end fittings of the shock absorber take all the load. Although this adds to the cost of the shock absorber assembly, it simplifies considerably the frame structure at the attachment points. With this arrangement, of course, the shock absorber end fittings have to be larger than if the spring seating pans were mounted directly on the frame in the usual manner.

Torsion bar suspension springs are not widely employed on British cars. In most instances, where they are fitted, they are at the front. The choice between torsion bars and coil springs for the front suspension is more a matter of which type is best suited to a particular chassis layout than to the mechanical properties of this type of spring. However, in some installations, the torsion bars can be conveniently adjusted to trim the vehicle height.

One of the few British cars fitted with torsion bar front suspension is the Riley Pathfinder. This model has a wishbone type upper tranverse link and a single-arm lower link on each side. Drag loads are taken by struts attached to the outer ends of the lower links. The rear ends of these struts are rubber-mounted on the frame. The inner end of each lower single arm is attached to a long torsion bar.



The Lotus Mk IX chassis has a swing axle type front suspension and the drag loads are taken by radius arms pivoted on the frame just forward of the dash

The Armstrong Siddeley Sapphire front suspension has forged wishbone links both at the top and bottom, and the semi-trailing layout has been adopted. Rubber bushes are employed in the pivots at their inner ends. The pivots of the lower link are widely spaced to react drag and brake torque loading. Anti-roll bars are fitted both at the front and at the rear.

The front suspension of the new Sunbeam Rapier has conventional unequal length wishbone arms, trailing slightly to the rear. A ball and socket joint is used at the outer end of the top wishbone and a short swivel pin and trunnion on the lower link. Metal bearings are used at all pivot points. This, it is claimed, gives more precise control and less friction than the alternative rubber bushes. The coil springs seat on the lower wishbone arms and a thick rubber cushion is inserted between the upper ends and their seating on the cross member. Telescopic dampers are mounted coaxially with each coil spring. A rubber bush is fitted in the attachment point at each end of the shock absorbers to insulate the frame and body structure from vibration and to allow a certain amount of universal movement.

A very compact front assembly unit is employed on the Borgward 1½ litre model. It comprises the independent front suspension, steering box and linkage, engine and gearbox, all mounted on a pressed steel cross member attached to the chassis frame. From the production viewpoint, and for replacement purposes, this design of a complete front end assembly has much to commend it.

STEERING

New Power-Assisted Steering Units Introduced

IN general, the design of steering mechanisms has changed but little in the past few years. The recirculating ball type appears to be gaining in popularity. It is, of course, difficult to improve on the rack and pinion layout, so far as positive feel is concerned, but with some suspension systems the kick-back with this type of steering is severe.

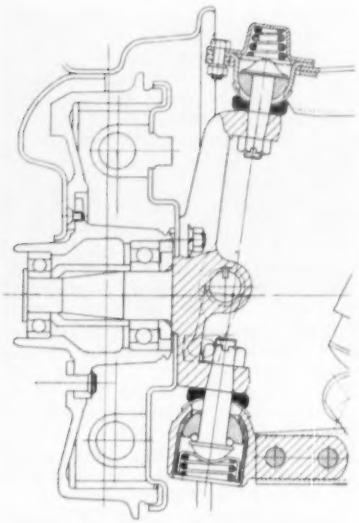
There is a trend towards the use of ball joints for king-pin bearings, in some instances both at the top and bottom, and in others at the top only. The advantage of this type of bearing is that it is simple, and easy to replace. Some manufacturers still prefer screw type king-pin and trunnion bearings, which can accommodate relatively heavy thrust and journal loads.

Considerable interest is being shown in power-assisted steering and, judging from its popularity in America, it is likely to be used increasingly in the larger types of vehicle. Among the features that tend to make power-assisted steering more desirable are: increased front wheel loading, due to the trend towards installing the engine further forward, and the adoption of low pressure tyres. Among the inherent advantages of power-assisted steering are: the reduction of steering kick and ease of manœuvre in confined parking spaces and on alpine hairpin bends.

It is interesting to note that Armstrong Siddeley 1956 models can have the Girling power-assisted steering system. This equipment is offered as an optional extra. An interesting feature of this system is that the degree of power assistance is variable. It can be adjusted by the driver without stopping the car, and can even be put completely out of operation.

This new Girling power assistance system comprises three units. One is a hydraulic fluid reservoir mounted on the left front-wing valance. The second is a Hobourn Eaton pump, mounted at the front on the left-hand side of the engine and driven by a belt from a double-pulley on the front end of the crankshaft. Thirdly, there is the hydraulic jack and control valve, embodied in the steering linkage. The pressure of the hydraulic fluid is limited to 700 lb/in², by a relief valve incorporated in the pump circuit. Fluid is fed to the jack by a flexible hose and is admitted by the control valve to one side or the other of the hydraulic piston. A bracket attached to the left-hand side of the chassis frame carries the end of the piston rod, and the cylinder is attached by a ball and socket joint to the steering box drop arm. The inner ends of the two-piece track rod are attached to brackets on the hydraulic cylinder.

The control valve is in the end of the hydraulic cylinder, and is connected by a universal joint to the socket of the ball joint on the steering box drop arm. This valve is very sensitive and, as



The Thompson steering and suspension ball joint arrangement

soon as it is displaced from its neutral position by movement of the steering wheel, admits oil under high pressure to the piston. However, since the ball is maintained in position in its socket by a strong spring, the valve is not displaced from the central position until a force sufficient to compress the spring is applied. This represents a force of two or three pounds at the steering wheel. Thus, the initial movement of the steering wheel does not bring the power steering system into operation.

A compact power-assisted steering arrangement has also been developed by Automotive Products Ltd. It is designed to be fitted in place of the centre track rod of a three-link steering system. The valve end of the unit is attached to the steering drop arm by a ball joint, and connected to the idler lever, also by a ball joint. Ball joints for the outer tie rods are mounted on housings, and a link secures the piston rod to the chassis. The pump unit, comprising a supply tank, relief valve and flow valve is engine mounted, and is driven by belt from the crankshaft.

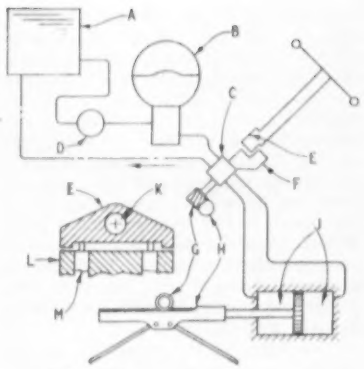
In the valve and jack unit, a hardened steel valve works in a cast iron body which has four cut-off points. An annular space between the first and second cut-off points is connected to a reaction area and to the space above the piston. Another annular space, between the third and fourth cut-off points is connected to a second reaction area and to the space below the piston through a space in the double wall of the jack tube. The inlet port from the pump is connected to the valve by way of the first and fourth cut-off points, while the return port is connected by the second and third points. A recuperation valve is placed between the inlet and outlet ports. The piston is attached by bolt to the steering arm ball joint, which can slide within its housing, with its travel limited by stops.

With the engine idling, fluid from the pump enters at the inlet port and through all four cut-off points to the supply tank. If the steering arm travels to the left, the valve moves to prevent passage of fluid through the second and fourth cut-off points. This causes pressure to build up above the piston and in the first reaction area. The pressure acting above the piston assists the movement of the steering gear to the left; that in the reaction area allows the driver to retain the feel of the steering. Assistance for steering to the right is obtained in a similar manner, with the difference, of course, that the second and fourth cut-offs are opened and the first and third closed.

Should the input load exerted by the steering drop arm exceed that required to operate the relief valve, full movement of the valve occurs, and additional effort at the steering wheel does not produce further power assistance. At engine speeds above idling, high back pressures are prevented by a flow valve in the pump unit, which bypasses excess fluid to the inlet side of the pump. The degree of power-assistance is directly proportional to the driver's effort at the wheel; this is maintained until the relief valve opens.

Another power-assisted steering system, which is still undergoing development, was shown by Whiteley (Rishworth) Ltd. This unit differs from the others in that the valve is in the piston of the jack. The closed end of the jack is attached to the vehicle structure. A two-piece piston rod is employed. It comprises an inner and an outer component. One end of the inner component is attached to the steering drop arm and the other end is passed into a hole in the slide valve, to which it is secured. Thus, movement of the steering gear tends to move the slide valve, the casing of which is formed by the hollow piston of the jack. The outer component of the piston rod is simply a sleeve round the inner one. It is sealed at the end adjacent to the steering drop arm, and at the other end it is screwed into the piston and spigots into the slide valve.

Round the slide valve are three grooves. The centre one is connected by radial ducts to the hollow inner component of the piston rod, and the outer two are connected by drilled ducts to the interior of the



A Reservoir
B Main accumulator
C Rotating union
D High pressure pump
E Striking plate
F and L Valve body
G Pinion
H Rack
J Rack control cylinder
K Axis of steering column
M Valves

Citroën DS19 power steering

sleeve component of the piston rod. Hydraulic oil under pressure is taken through a flexible pipe to the axial hole in the inner component of the piston rod and then to the centre of the slide valve, whence it passes through the radial holes to the intermediate groove. The outer two grooves on the slide valve are for exhausting the fluid from the low pressure side of the piston into the sleeve component of the piston rod and thence through another flexible pipe connection to the reservoir.

Two flats are machined, diametrically opposite one another, on the outer periphery of the piston. They do not extend the full length of the piston; instead they break out at alternate ends. Valve ports are drilled radially,

A two-piece track rod steering layout has been adopted on the Fiat 600

one from each flat, to communicate with the cavity in the piston. These ports are so positioned, one near each end of the piston, that when the steering gear is centralized, they uncover simultaneously, and so interconnect the intermediate groove and the outer pair on the slide valve. Thus, in these circumstances, high pressure oil can flow directly to the exhaust system and the pump is not working under load. Movement of the steering gear in either direction places the intermediate groove in communication with one port and, at the same time, one of the exhaust grooves with the other port.

The flats on the periphery of the piston are so arranged that the high pressure oil is fed to that end of the piston on which it tends to supplement the force applied by the steering gear. A duct is drilled from the flat to the opposite end of the slide valve to provide feel back. The corresponding duct and port in the other flat are, of course, in communication with the exhaust system.

With this arrangement, there can be no tendency for the vehicle to over-steer due to the power-assistance continuing after the motion of the steering wheel has ceased. This is because the piston centralizes itself automatically relative to the slide valve; were it to go past the central position in either direction, the appropriate ports would be uncovered to correct the error. Another feature of the unit is that shocks applied to the system from the road wheels tend to be damped out. The unit operates at about 750 lb/in^2 hydraulic pressure, and the feel-back applied to the steering gear is approximately 25 per cent. In the event of failure of the hydraulic pressure, direct manual operation is obtained.

Automotive Products Ltd., the manufacturers of the well known Thompson self-adjusting steering rod, have introduced a new combined steering and suspension joint which has several novel features. The upper and lower components of the joint incorporate taper pins attached to the steering swivel, and they are secured by slotted nuts and locked by split pins. The top joint, that is, the one that takes the smaller load, has a hemispherical bearing retained by a shoulder at the upper end of the pin. This bearing is housed in a pressed steel cup attached to the suspension arm and is held in position by a spring-loaded washer, the spring being interposed between the spherical head of the pin and the housing. The lower, or heavy load carrying joint, is of similar design except that a ball thrust bearing is fitted between the shoulder of the pin and the hemispherical bearing.

This type of joint is self-aligning and therefore accommodates relative movement between the upper and lower wishbone arms, due to deflection of the rubber bushes under heavy loading, for example, during braking. It also reduces the number of lubrication points to four. The fact that the ball joints incorporate a large reservoir for grease is an important factor, so far as the life and frequency of lubrication of the joint is concerned. Two moulded Neoprene-sponge seals are employed to retain the grease and to keep out moisture and abrasive matter. These seals are interposed between the swivel carrier and the joint. They are carried in dished washers and bear against cupped pressings, which in turn seat on the machined, spherical outer surfaces of the ball housings.

On the Citroën DS19 2 litre saloon car, the steering gear is of the rack and pinion type, which has been used for many years on earlier models. It is a design well-suited to independent suspension, since it requires no slave levers, and only four ball joints are needed, as compared with six for the three-piece track rod type of layout. This system also has the advantage that backlash can be eliminated even when the gears are worn. In most designs the backlash is taken up by a plunger that bears on the back of the rack and forces it into engagement with the pinion.

Like all front-wheel drive vehicles, the loading on the front wheels of the Citroën DS19 is relatively high. Also the loads due to driving or over-run, on the steering pivots and constant-velocity joints tend to make the steering heavy. For these reasons, no doubt, the designers of the new Citroën model have deemed it necessary to fit larger tyres on the front wheels than on the rear, and also to introduce power-assisted steering.

The hydraulic unit for the power steering is attached to the rack. It is controlled by two distributor valves at the lower end of the steering column, which is split into two semi-cylindrical segments. The two flat faces of these segments overlap. Two valves, one for each direction of turn of the steering wheel are carried in the lower half. These valves control the flow of oil under pressure, directing it to one side or the other of the booster cylinder. In the event of hydraulic failure, mechanical connection is made between the halves of the end of the column.

On the Sunbeam Rapier the steering linkage layout is unusual in that the centre section of the three-piece track rod is above the clutch bellhousing. The steering box arm, which is pivoted at the centre, is duplicated by an idler arm of the same pattern on the opposite side of the vehicle. These arms are attached at their lower ends to the outer sections of the track rod and at their upper ends to the centre section of the rod. This arrangement enables the column to be well raked and makes the best possible use of the space available in the engine compartment. It has been made necessary by the forward position of the engine.

There is a growing trend towards the use of rubber bushes in place of metal joints on the ends of the centre rods of three-piece track rods. The advantage of using rubber for this application is that it reduces the number of lubrication points and introduces a slight amount of resilience into the linkage, which helps to absorb shock loads from the road wheels. A slight increase in steering effort is required to deflect torsionally the rubber bushes from the neutral position. This introduces a slight self-aligning torque.

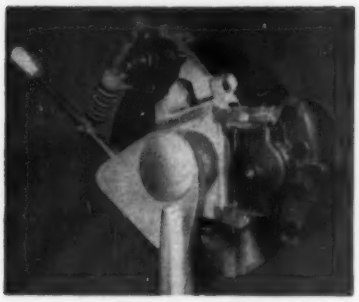
BRAKES

New Vacuum Servo Units Introduced. Disc Brakes Further Improved

OWING to modern traffic conditions and the high speeds of present-day cars, braking equipment efficiency is a matter of utmost concern. In a number of instances increased efficiency has been sought by widening the shoes to obtain greater friction areas. Furthermore, hydraulic application, with vacuum servo assistance, to give greater braking power with lighter pedal pressures, is not only almost universal for the faster and heavier cars, but has extended to many of the lighter classes.

The proprietary equipments that provide power-assistance have undergone improvement, and a number of new designs made their first appearance at the Show. To obtain the required ratio between front and rear wheel braking effect, the fitting of two leading shoes at the front and leading and trailing shoes at the back is continued in the majority of cases, although not without exceptions. A number of new brake linings of moulded and woven materials, designed to afford greater resistance to wear and to solve fade and squeal problems, have also been introduced.

During the past twelve months, progress has been made in the development of the disc brake. However, there was no indication at this year's exhibition that the production and use of disc brakes on an extensive scale is imminent. The merits of these brakes, as demonstrated by the performance of units fitted to high-powered cars, are sufficiently well established to justify the application of this type of brake under the less exacting conditions that are experienced in ordinary private motoring. Development has now reached the stage where at least one of the British manufacturers confidently state that they are now ready to go into full scale



Lockheed mechanically and hydraulically applied disc brakes

production of disc brakes.

From impressions gained at the Show, it appears that the general adoption of disc brakes in place of those of the drum type depends upon car manufacturers' readiness or otherwise to adapt them to their chassis designs. At present, the demand of the public for these types of brakes is uncertain; moreover, the cost and disturbing effects that their incorporation in existing designs would have upon production programmes, particularly where these are conducted on a mass scale, is an added deterrent to their widespread adoption. An important requirement is that the equipment offered should be readily adaptable to cars of many different types and makes.

Those who believe in the future of disc brakes will have been encouraged by their appearance on the front wheels of the new Citroën DS19 car. On this vehicle, the front brakes are mounted inboard, on the half shafts. Together with the leading and trailing shoe brakes on the rear wheels, they are applied by a hydraulic system that also serves the clutch, gearbox, steering and hydro-pneumatic independent suspension. Hydraulic power is provided by a belt-driven, high-pressure pump used in conjunction with a main accumulator. There are also individual accumulators for the front and rear brake circuits. Each circuit incorporates a distribution valve having pipe connections to the respective accumulators and to the hydraulic brake cylinders at the wheels.

For brake application, the two distributor valves are opened by only slight depression of the brake pedal, which actuates a common striking plate. The distribution of the braking force between the front and rear brakes is automatically adjusted according to variation of load on the rear axle. Since the two brake systems are entirely separate, the effectiveness of one is not impaired by failure of the other.

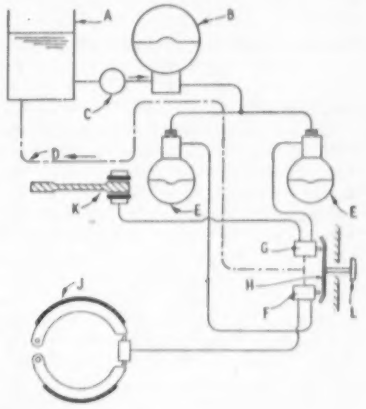
The friction pads act on both sides of each front brake disc and are automatically adjusted for wear. Air admitted through ducts from the front of the vehicle cools the brakes. There is no hand lever for the front brakes; instead they are operated mechanically by a pedal, on the left of the driver, which actuates a system of cables and levers. For parking, the pedal is depressed and is then locked by a separate control, fitted with a safety catch, under the facia. No doubt the pedal control of this brake is a useful feature in the event of failure of the hydraulic brakes.

Lockheed's most recently developed disc brakes for cars of over 30 cwt gross weight are the same for application to the front as to the rear wheels, except that the front brakes have a greater volume of friction material and the cylinder area is larger to give the additional braking effect required. Brakes of the smaller type may be fitted to both front and rear wheels of cars weighing under 30 cwt and, unlike those of the heavier class, do not require servo assistance.

As in the earlier design, two segmental friction pads are applied to each side of a cast iron disc. Application is effected by hydraulic pressure exerted on a single piston in an aluminium cylinder bolted to the inner face of a caliper of malleable iron. The piston applies thrust to a pressure plate and, since the pivoted link mounting of the caliper on the torque plate allows the caliper to move axially, the pressures of the pads on the disc are equalized. These links also help to ensure that the wear on the friction pads is uniform.

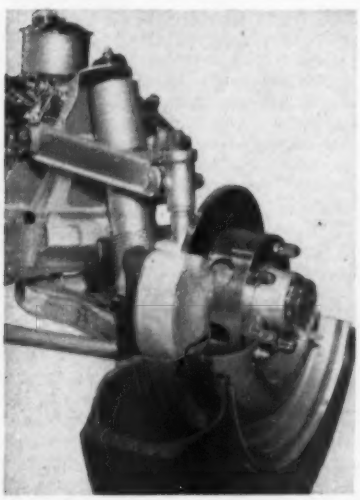
Sandwiched between the caliper and cylinder is a plate that locates a piston return spring, which maintains a slight clearance between the pad and disc when the brake is off. A wiper seal prevents the entry of dust and dirt into the annular chamber around the piston. A spring-loaded pin presses against the torque plate and the friction between this and the caliper prevents rattle.

The brake clearance can be set by an adjusting screw, which is held in the cylinder head by a lock nut and registers in the piston. A hollow cone of spring steel has six teeth, or pawls, formed on its small end. These teeth are bent in to engage in the thread of the screw, and though they trail over the thread in the direction of operation, movement in the opposite direction is resisted. A positive increment adjuster is thus provided and clearance is maintained within close limits. By undoing a nut and withdrawing the caliper-mounting pivot pin, the caliper and pressure plate can be removed for renewal of the pads. To make room for the new pads, the lock nut is slackened and the adjusting screw rotated so that the cone spring runs down the thread, allowing the piston to be moved back. For the rear brake disc, a separate caliper unit carries smaller circular pads, which are applied by a face cam operated

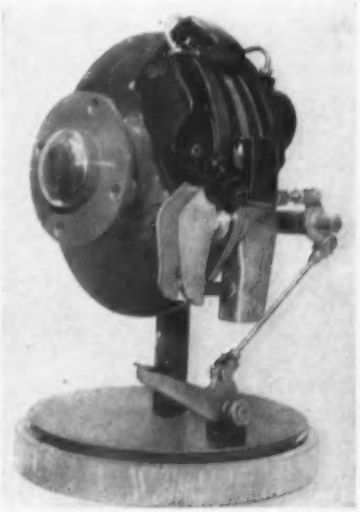


A —Reservoir
B —Main accumulator
C —High pressure pump
D —Return
E —Accumulator for front and rear brake circuits
F —Distributor valve for rear brakes
G —Distributor valve for front brakes
H —Striking plate
J —Rear brakes (drum type)
K —Front brakes (disc type)
L —Brake pedal

Diagrammatic illustration of hydraulic brake circuit on the Citroën DS19



Lockheed front wheel disc brake



Girling improved design of rear disc brakes

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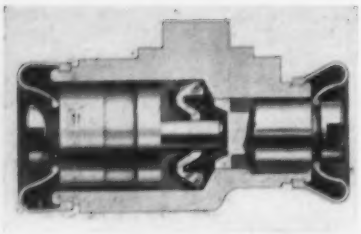


Lockheed Brakemaster front wheel brake cylinder

mechanically with a hand lever control.

In its latest improved form, the Girling disc brake is said to be ready for production for private cars. An actual example of its application exhibited at the show was the front and inboard rear brakes of the Lotus Mk IX racing and competition car chassis, for which it was specially developed. Like the earlier version, this brake has segmental friction pads, of substantial thickness, bonded to steel plates. These pads are pressed against each side of the disc by the pistons of two hydraulic cylinders, one for each pad. A balance pipe connecting the cylinders equalizes the pressures. The front and rear brakes are similar, though the rear brake has additional pads actuated mechanically by a hand lever.

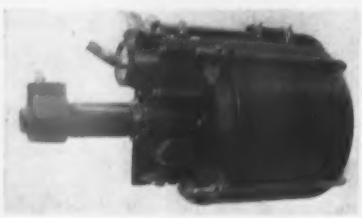
The caliper carrying the cylinders and pads is open at the centre so that the state of wear of the friction pads can be checked at a glance. Adjustment is automatic and is based on the Hydrastatic principle. The pads always remain close to the disc surfaces so the hydraulic fluid displacement and pedal travel are reduced to a minimum. On the Lotus chassis the front and rear wheel brakes are applied by two separate master cylinders mounted side-by-side on a platform behind the engine. Operation is by a pendant pedal acting on a centrally pivoted beam that equalizes the application of pressures.

It is stated that tests have shown that the life of the pads is greater than that of shoe linings in the drum types of brake. In this connection it is of interest to refer to the experience of the Birmingham and Midland Omnibus Co. Ltd., which has single-deck buses, fitted with Girling disc brakes, that have operated over a million miles. Speaking at a recent meeting of the Institution of Mechanical Engineers, the Company's chief engineer, Mr. S. C. Vince, said this experience indicated that a 1 in thick disc friction pad has a life of about 80,000 miles as compared with 60,000 to 70,000 miles obtained with drum brake linings under similar service conditions.

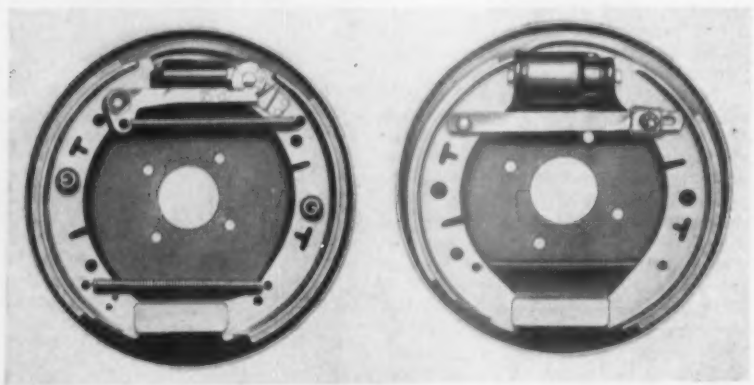
Servo units

The new Lockheed Brakemaster power braking system, for high-performance cars, is an example of a departure from the practice of fitting two leading shoes in front wheel brakes. With this system, leading and trailing shoes are employed at the front as well as at the rear. The arrangement is designed to obtain balanced pressure, and thus equal wear on the shoes, reduced sensitivity to alterations in the frictional characteristics of the linings, and a brake factor such that excessive servo assistance is not needed.

Balanced pressure for the front brakes is obtained by fitting a single hydraulic cylinder at each wheel. The two pistons in each cylinder are of different diameters to compensate for the low factor of the trailing shoe, the ratio of shoe tip effort as between the leading and trailing shoes being $2\frac{1}{2}$: 1. This produces equal shoe drag and lining wear. Standard Lockheed practice is followed for the rear brake cylinder, which can move in a slot in the backplate and applies, either hydraulically or mechanically, equal operating pressures to the two shoes.



Clayton Dewandre Bendix Hydrovac servo unit



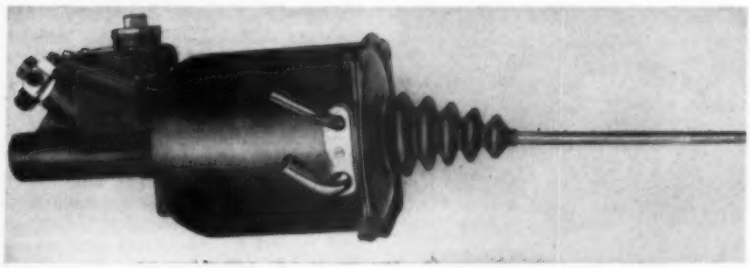
The Lockheed front and rear brakes, as used in the Brakemaster system, have automatic adjusters

Vacuum servo arrangement of the Lockheed Brakemaster system

Both brakes have automatic adjusters similar to types exhibited at Earls Court last year, when a vacuum servo unit basically the same as that used for the Brakemaster system was first exhibited. The Brakemaster is connected by pipe line to a normal, Lockheed master cylinder. It comprises vacuum and atmospheric valves attached to a balancing beam, in a chamber above which is a reaction diaphragm with its upper face permanently exposed to atmospheric pressure.

Normally both sides of the vacuum piston are subject to atmospheric pressure. When the pedal is depressed, a control valve piston connected to the centre of the balance beam is actuated by fluid pressure from the master cylinder. This lifts the balance beam: at its first movement the atmospheric valve is closed by a return spring. The vacuum inlet valve is then opened and depression proportional to the pedal movement acts on the back of the piston, which operates the servo. The depression in the chamber causes the diaphragm to react until it balances the pressure in the hydraulic circuit. Air pressure on the piston applies a thrust to the servo cylinder plunger; this is transmitted to the slave piston, and adds to the pressure in the fluid in the circuit between the master cylinder and the brakes. The ratio of input to output pressure is constant up to the limit of the depression given by the vacuum supply.

The first Girling vacuum servo to be produced is intended for use with hydraulically applied two leading shoe brakes. It is fitted to a number of cars that were exhibited at Earls Court. Response to variations in hydraulic pressure from the master cylinder is obtained without appreciable time lag, so the possibility of an uncontrollable surge of hydraulic force to the wheel

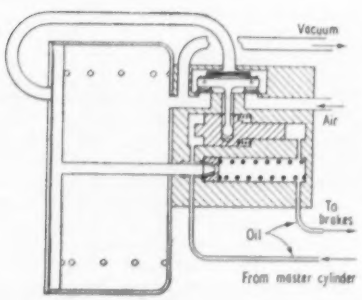


Clayton Dewandre Bendix Treadle-Vac servo

cylinders is eliminated. Therefore, the braking effort is at all times progressive and immediately responsive to the driver's effort.

Control of the vacuum-operated piston is by means of two poppet valves mounted on a T-shaped rocking lever. One valve controls a port to atmosphere and the other a port on the vacuum side of the unit. The lever is rocked by the resultant action of opposed, interconnected pistons of different sizes, the larger one being subject to the pressure in the hydraulic pipe line from the master cylinder, and the smaller one to the pressure applied to the system by the servo unit. Thus, the ratio between the areas of the pistons establishes, within the limits of the power obtainable from the vacuum, the ratio between the input and output pressures in the hydraulic system. Adequate forces are thus available to actuate the valves and the unit is quickly responsive to variations of input pressure and commences to operate at very low pedal pressures.

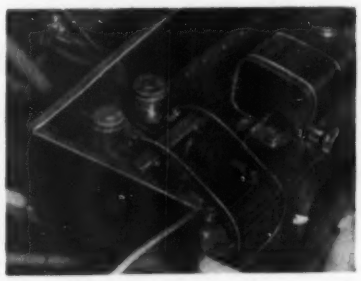
The servo is available in two forms. One works on the direct vacuum principle and is suitable for installation in a relatively clean position close to the source of vacuum. It has a wire gauze filter for the vacuum cylinder breather and an oil-wetted, knitted wire filter for the air that passes through the valve and eventually to the engine. The other version works on the suspended vacuum principle with vacuum on both sides of the piston in the balanced condition, air being admitted to one side when an effort from the piston is required. This unit is intended for installation in positions subject to dirty conditions or at a distance from the source of vacuum.



Girling brake servo unit

It is a sealed unit with a common air inlet for the servo cylinder and valve. An oil-wetted knitted wire filter provided for the inlet may, if desired, be mounted a short distance from the servo, where the conditions may be cleaner.

New to this country are the American Bendix Treadle-Vac and Hydrovac



Twin cylinders are employed to actuate the Girling disc brakes on the Lotus chassis

servos now being manufactured by Clayton Dewandre Co. Ltd. The former is made in two sizes and is intended for pendant pedal operation. Its input rod, which carries the servo piston, is coupled by a ball joint to the hydraulic master cylinder. This cylinder is of the piston rod displacement type. From the production aspect, this is preferable to the close-fitting piston arrangement, for which accurate machining and a good finish on the cylinder wall are essential to prevent leakage of hydraulic fluid past the piston. In this unit, the cylinder is a casting with an unfinished interior surface, and leakage of fluid is prevented simply by the provision of a sealing gland for the piston rod. The fluid inlet to the master cylinder is fitted with a valve which closes at the initial movement of the piston rod for brake application.

In the servo cylinder, a hairpin member controls the vacuum and atmospheric valves, and a piston is controlled by a diaphragm which reacts against the effort applied to the input rod. The first movement closes the atmospheric valve, and further motion causes the vacuum valve to be unseated, permitting vacuum to become effective on the servo piston to assist the driver, and on the diaphragm to offer the appropriate resistance to the driver's effort. When the vacuum is increased by further movement of the pedal, the vacuum valve is opened, to increase further the depression in the diaphragm chamber and vacuum side of the piston. When a balance is reached, the vacuum and atmospheric valves are seated. If the pedal is released, the balance between the driver's effort and the reaction diaphragm is destroyed and the atmospheric valve is opened, the depression in the cylinder and diaphragm chamber is reduced and the pressure to the brakes relieved accordingly.

The Bendix Hydrovac servo is designed for inclusion in hydraulic braking systems to boost the hydraulic pressure to the wheel cylinders. It is also supplied in two types, working respectively on the direct vacuum and suspended vacuum principles. The former is in its main essentials similar to the well known Clayton Dewandre V.O.M. servo and can be mounted in any convenient position on a chassis. The degree of assistance it affords is progressive throughout the full travel of the brake pedal and is proportional to the effort applied, up to the maximum vacuum in the induction manifold at the time of application. Direct communication between the master cylinder and wheel cylinders permits the brakes to be applied by pedal effort alone should the vacuum system fail. The suspended vacuum version of the Hydrovac ensures quicker responsive action and is intended primarily for commercial vehicles.

On a number of cars of the larger class, such as the Cadillac La Espada, Dodge 161 and Plymouth Belvedere, equipped with automatic transmission units, the space normally occupied by a clutch pedal is utilized by widening the brake pedal to about 9 in or 10 in.

Feeny and Johnson trailer brake valve and control assembly

This enables the driver to apply the brakes with his left or right foot, as may be desired. The car can thus, for instance, be held stationary on an up gradient with brakes applied readily by the left foot and with the right foot in position to open the throttle as the brakes are released, instead of having to transfer from one pedal to the other, and without using the hand brake.

It is a matter of opinion as to the best type of hand brake control and the most convenient and effective position for it. Some manufacturers favour the pull-on type under the facia and others a hand lever beside the driving seat. Another arrangement that gives more convenient operation than either of these common alternatives is the hand lever mounted with the change speed control on the steering column, just below the steering wheel, as on the Singer Hunter 75. To apply the brake, the driver pulls this lever towards him with his right hand. The ratchet pawl is controlled by movement of a short centrally pivoted extension of the hand lever. When the inner end of the lever is deflected by grasping the outer end to apply the brake, the pawl is disengaged, but is re-engaged by a spring when the lever is released. It is disengaged by a light touch on the outer end of the extension to release the brake.

On the Cadillac La Espada, the wide pedal enables the driver to apply the brakes with either foot

The braking equipment of caravans exhibited showed no important departures from well-tried practices. However, the latest improved hydraulic equipment, exhibited by Feeny and Johnson Ltd., for caravan and trailer brakes, is of interest. This is a standard feature of a number of makes of caravan and is optional on others seen at the Show. It was mounted, for display purposes, on a steering column, with a finger-tip control for a new hydraulic reaction valve. This valve is more sensitive and capable of handling larger capacity power units than the previous type and it is fitted at the lower end of the column. Operation of the finger-tip control applies only the caravan brakes, while depression of the brake pedal also brings these brakes into operation slightly in advance of those on the towing car.

ELECTRICAL EQUIPMENT

Increasing Lamp and Accessory Load and Simplified Controls

WITH regard to electrical equipment, the outstanding feature of the Motor Show was that almost without exception, 1956 cars have far more electrically operated accessories and components than their predecessors. To some extent this was expected, particularly since additional accessories such as supplementary lamps and windscreen wipers and washers make for greater road safety. But manufacturers have gone much further: most cars have refinements, such as radios and heaters, or at least provision is made for their optional fitting. Moreover, there was a marked increase in the electrical operation of body and chassis components, ranging from windows and driving seats to clutches and overdrives, and even to the principles of suspension.

These developments have three counterparts. First, there is the employment of a higher capacity dynamo to meet the demand of the increased lamp and accessory load. Second, in order economically to reap all the benefits that a higher capacity dynamo can bestow, its method of regulation has to be of the latest current-voltage variety. Third, with so many accessories and components depending upon electrical operation, the need arises for simplified controls.

Dynamos and control boxes

For cars on which the electrical load is relatively low, the compensated voltage control system of dynamo regulation continues to be employed. This system has been in vogue on the majority of British and Continental cars for some twenty years. It has met with great success and will, no doubt, continue to be used on vehicles where the dynamo is of a comparatively low capacity. When first it was introduced on British vehicles, the maximum output ratings of the dynamos of that period were, by to-day's standards, rather low. Most of the dynamos at that time were of the non-ventilated type and had, in consequence, very low outputs. Given sufficient daytime running, however, they could keep the battery charged and supply a modicum of lamps and accessories.

During the years that have followed, there has been a steady increase in lamp and accessory loads. This necessitated the increasing adoption of the ventilated type dynamo with its larger outputs, and later improvements in dynamo design leading to the modern machine, as for example, the Lucas model C47PV-0, of still greater output. Consequently, the degree of dynamo protection required from the compensating coil of a standard compensated voltage control regulator became less with each increase of dynamo output, and this, of course, necessitated corresponding reductions in the number of turns of the coil. In its original form, the coil had only a few turns, about ten, and such reductions were sorely limited, particularly if the sensitivity of the regulator to changes of load is not to be seriously affected. Because of this, and also because of the advantage to be gained by obtaining a high and prolonged initial charging rate in order to restore the battery to a reasonable state of charge in the shortest possible time, compensated voltage control regulation is, where high capacity dynamos are concerned, giving place to the latest form of current-voltage control.

In American 6-volt circuits with their heavier currents, current-voltage control has found almost universal application, as it has in both 12- and 24-volt circuits for British passenger service vehicles. Now, quite a number of British and Continental cars have adopted it, and many more are rapidly approaching the stage where its adoption becomes necessary. Autolite, Bosch, Delco-Remy and Lucas, therefore, have introduced high capacity car dynamos and current-voltage control boxes to meet this need.

A current-voltage control system employs two regulators. Of these, one is shunt wound so as to be responsive only to voltage; the other is series wound so as to be responsive only to current. The contacts of both regulators are arranged in series with the dynamo shunt field winding and a short low resistance coil on the voltage regulator core. The low resistance coil is a frequency coil for ensuring rapidity of regulator armature movements. It is, of course, wound and connected so as to act cumulatively with respect to the voltage regulator shunt coil.

As the dynamo speed is increased from rest its terminal voltage rises, the field being energized through the normally closed contacts of the current and voltage regulators and the low resistance frequency coil of the voltage regulator. When the dynamo reaches cut-in speed, the cut-out closes in the usual way, so connecting the dynamo to the battery.

Further increase in speed results in a rise of dynamo terminal voltage until, under normal conditions, the operating voltage setting of the regulator is reached. At this point the voltage

regulator contacts open, thereby inserting the contacts' resistance into the field circuit while throwing the frequency coil out of action. As a result the regulator armature is set into rapid vibration and the dynamo voltage is limited to a pre-determined value.

If, however, owing to a discharged battery or a large electrical loading, the circuit voltage does not rise to that at which the voltage regulator comes into operation, an auxiliary means of limiting the dynamo output current to a safe value is necessary. This is effected by means of the current regulator. When the current output of the dynamo reaches its maximum rated value, the electro magnetic effect of the circuit flowing through the series winding of the current regulator causes the armature to be attracted, so opening this pair of contacts and thereby again inserting the contacts' resistance into the field circuit. Consequently, the current regulator armature is set into vibration, imposing a limit on dynamo current.

On starting to charge a fully discharged battery, the voltage of the system is too low for the voltage regulator to operate. The current regulator, therefore, permits the full rated output of the dynamo to pass to the battery. This continues until the battery approaches a charged condition, at which stage the voltage of the system becomes sufficiently high to commence operation of the voltage regulator, the current falls and the current regulator ceases to operate. In practice, a change-over period exists during which both regulators are in operation. It will, therefore, be seen that the dynamo gives its maximum rated output under the safeguarding control of the current regulator, for all battery voltages below that at which the voltage regulator is set to operate. As the battery becomes more nearly fully charged, the voltage of the system rises to the operating voltage of the voltage regulator which then controls the dynamo output according to the load and state of the battery. Finally, when the battery is fully charged, the charging rate is reduced to a low trickle value which keeps the battery healthy.

With the exception of minor details of construction, the various makes of control boxes for effecting current-voltage control are the same. The three units, cut-out, current regulator and voltage regulator are arranged upon a common base and enclosed by a single cover. A typical example is the Lucas model RB310 control box, which, incidentally, is employed in conjunction with the Lucas model C47PV-0 dynamo. This dynamo, recently introduced, has an output of 30 amp, is supplied in screened and unscreened form. It has provision for built-in radio interference suppression capacitors and finds wide application on police cars equipped with two-way radio.

The RB310 control box is now fitted as standard to a number of cars notable among which are the Rolls-Royce Silver Cloud, Jaguar XK140, Vauxhall Cresta, Wyvern and Velox. Its armatures are of the bell-crank lever type, a type which has found much success on Lucas compensated voltage-control boxes. In mechanical construction, however, it differs from the earlier compensated voltage-control boxes by employing separate magnet frames for each unit, screened contact adjustments for the two regulators and a pressed steel base and cover. Another important difference is that cut-out is temperature compensated, the method of temperature compensation being the same as that for the voltage regulator, that is, bimetal armature spring.

Batteries and lamps

In the main, the exhibits were of well tried products. Among the batteries were specimens of the Ediswan low-priced Crown range, the Standard range and the high quality Extra Life range in which micro-porous separators are used. Exide exhibits included the Silver Exide with its Porvic microplastic separators, which are pliable but tough, over 80 per cent porous and yet provide complete protection against shorts. Lucas showed the famous King of the Road, with its porous rubber separators and other features making for longer and more efficient battery life. A new type of dry charged battery, the Power Seal, was shown in the Oldham range.

For the Silver Exide, it is claimed that its separators make possible all-dry assembly so that batteries can be stored unfilled for an indefinite period without deterioration. Furthermore, its CB95 alloy plate grids, pasted with improved active material, give increased resistance to corrosion and greater durability, while its hard rubber container is tough, leak-proof and resistant to acid and vibration.

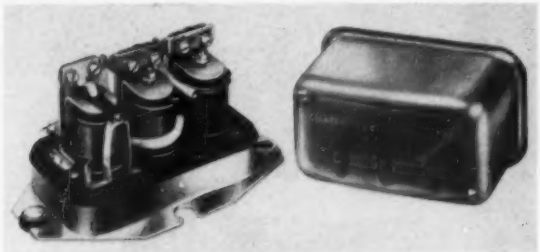
The Lucas King of the Road has many exclusive features. Not least among which are the special grid alloy used for plate manufacture, the toughened Milam case which is tested after manufacture with an electrical pressure of 60,000 volts and the absence of lead connecting bars, a feature which enhances appearance by giving a neat, clean-top assembly.

Dry charging of batteries, that is, assembling the batteries with plates in such a condition that on filling in, the battery is capable of giving 80 per cent of its rated capacity, has been practised for a long time. The reason, however, that it has not been applied on a larger scale arises from the fact that a dry micro-porous separator, essential for storage batteries of this type, has not been available.

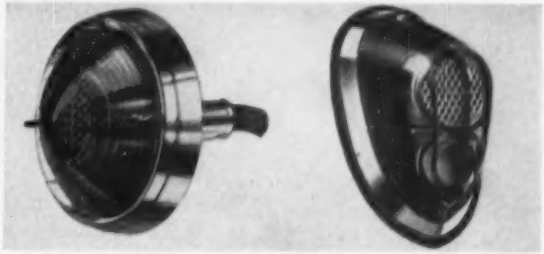
Now that separators of this kind, notably Fibrak developed by Oldham and Son Ltd. at their parent works at Denton and now also manufactured by their subsidiary companies in France and Australia, and under licence in the United States, are employed almost universally in batteries, the prospects of eliminating the long first charge when putting batteries into commission has led to much development work on the dry-charging of plates.

When positive and negative plates are taken from the formation vat, they are in a fully-charged condition, but on drying off, the negatives become severely oxided. It is, therefore, the recharging of the negatives which requires the very long periods of first charge before placing batteries in service. From this, it follows that if, after formation, the negative plate could be dried without exposure to the air, then there would be no oxidation and the battery would, on being filled, be capable of delivering a large proportion of its capacity. Various methods of conducting this drying-off process have been tried in the past, such as in an atmosphere of hydrogen and nitrogen or of burned gases (CO_2), in vacuum ovens and in an atmosphere of superheated steam.

All these methods resulted in plates which could give a large proportion of their capacity when the battery was



Lucas RB310 control box. Left to right: cut-out, current regulator and voltage regulator. All three units have bell-crank armatures



The Lucas stop and tail lamps that incorporate reflectors, which are now a legal requirement. The left-hand lamp is the Model 549 unit and the right-hand one is the Model 551

filled but, owing to the reactivity of these pure lead plates, especially in the presence of moisture, the tendency was for the plates to oxidize in storage, either when loose or when assembled in batteries, and to lose over a period the whole of their dry charge. With the Power Seal process, the negative plates are dried in the absence of air and at the end of the process each particle of lead in the extremely porous plates is coated with a layer of water-resisting medium which protects them from oxidation in storage and in the battery.

The water-resisting medium is perfectly permeable to battery acid so that as soon as the battery is filled it is ready to supply current at low rates, and, within half an hour of filling, is easily capable of starting the vehicle. Moreover, the efficacy of the medium is such that batteries, under storage conditions, retain their effective discharge capacity indefinitely. For example, a recent test showed that after six month's storage, a Power Seal battery delivered its full discharge, whereas a conventional dry charged battery had lost more than 50 per cent of its effective starting capacity. In view, therefore, of the fact that the rate of loss falls with time, it is quite evident that this new method of dry charging results in an extremely long storage life.

In addition to the numerous established products, new types of lamps were shown on the Lucas, Marchal and Notek stands. The modern trend, it appears, is to incorporate the now obligatory reflectors, in the rear lamps. Two such lamps for replacement or modernization purposes are the Lucas model 549 and 591. Both models are designed for fitting in pairs and incorporate a 21/6 watt non-reversible bulb enclosed by a red lensed cover moulded in red Diakon which is unaffected by weathering and impervious to paraffin and petrol. The performance of all Lucas rear lighting units exceeds by a considerable margin the minimum photometric requirements of the Lighting Act.

Marchal's contribution consisted of the new Fantastic lamps, representing an addition to the range of matched pairs of fog and driving lamps, and the new Optiques, representing the latest

The Cadillac La Espada, an experimental car, has Lucas fog and long range lamps installed side-by-side

versions of the established Equilux headlamp conversions. The Fantastic lamps have the new functional yet decorative air-flow lens-glass with a central dome designed to deflect rain and mud, etc., and formed with 90 deg circumferential prisms to intensify the light while trapping parasitic rays so as to reduce back-glare. They are French lamps with the contemporary shallow-build, the shallowness being such that nothing projects aft of the hollow bolt, universally jointed mounting. The design is remarkably clean and elegant and all components are made to precision. A rubber gasket between the glass and the reflector ensures effective sealing. There is a futuristic restrained motif at the top of the lamp rim. The designation 622 is given to the driving lamp, which, incidentally produces a beam of outstanding power, some 110,000 candlepower, with the standard bulb of 48 watts. The fog lamps, to be known as the model 660, give an extra wide penetrating beam, back glare being entirely eliminated by virtue of the Occulteur, a special bulb-shield, in combination with a special yellow bulb.

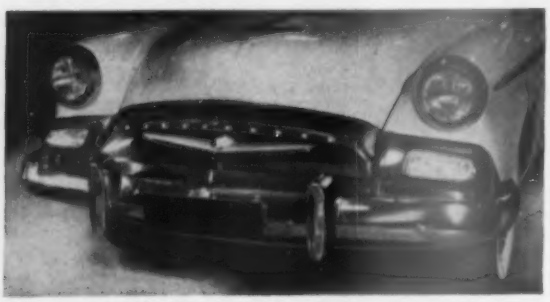
Easier to fit and giving greatly improved light distribution, the new Optiques are available in types suitable for British and American cars. They are particularly suitable for Continental touring, in that they conform to the requirements of the European Lighting Code, providing completely dazzle-free dipped beams without sacrificing the intensity of spread. The de luxe models are fitted with the Occulteur.

Blue-spot lenses and other notable features of the Lightmaster, Passmaster, Roadmaster and Speedmaster are retained in the Notek new Series 150 range. The optical units, however, are now housed in a circular body which, in being more shallow than those of previous designs, conforms to modern requirements. Another Notek product that is quite new is the Series 200 Hilite headlamp conversion set which, without alteration to most types of lamp, can be used for modernization purposes.

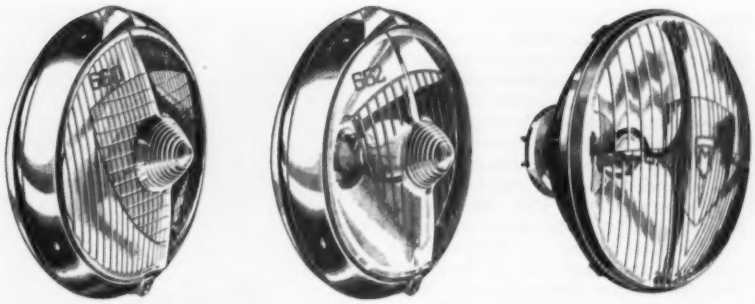
Future developments in headlighting are unpredictable. They may, possibly, despite the present legal requirements which vary from country to country, follow the scheme adopted for the Cadillac La Espada model, an experimental "dream car" exhibited on one of the General Motors' stands. This scheme consists of two comparatively small diameter lamps of equal size, housed side by side in the nose of each wing. It certainly looks attractive and gives every impression of being highly effective. The lamps themselves were Lucas productions based on the Lucas fog and long range models respectively.

The remaining new and outstanding lamp exhibits were two distinctive types of stop-tail lamp on the Tudor and Wingard stands respectively, the former showing the Model 291 Rite-Angle unit, and the latter, a pleasing and effective lamp incorporating a reflector. Still prominent among established Butler lines, of course, was the Saucer lamp which is available as a fog lamp, pass lamp or pencil beam driving lamp. It was shown together with a range of stop-tail lamps specially designed for caravans and trailers.

In general, the employment of twin fog lamps appears to be increasing. This arrangment has now been adopted on a number of cars, notable among which are the Daimler One-O-Four and the Wolseley Six-Ninety. Also increasingly used are courtesy lights controlled automatically by switches on the door pillars, and panel lights controlled by rheostat. Typical examples of one or both these features were incorporated in the Austin A50 Cambridge, Bristol 405, Daimler One-O-Four, Humber Hawk saloon and touring limousine, Standard Eight and Sunbeam Rapier. The designers of the Chrysler New Yorker and the Daimler



Two examples of typical American practice with regard to lamp arrangement. On the left is the Studebaker President, and on the right the Chrysler New Yorker



A selection of Marchal driving lamps. Left, Model 660 fog lamp; centre, Model 662 long range lamp; right, Model 6915 de luxe Optique headlamp

One-O-Four have gone further, by providing an illuminated engine compartment in the Chrysler model and an illuminated luggage boot in the Daimler.

On most of the high quality cars, incidentally, there were at least two interior lamps—a much needed improvement. Warning and reversing lights, too, are increasingly fitted, especially the former. There were warning lights not only for ignition, charging and headlight main beams, but also for direction indicators, oil level and/or pressure and petrol reserve. On the other hand, few models incorporated map reading lights. Three of the best applications in this direction were to be seen on the Bristol, Riley and Chrysler stands. The Chrysler arrangement was the most novel, in that the lamp was incorporated in the rear-view mirror.

Direction indicators and horns

Although flashing type direction indicators are fitted to more cars this year, the semaphore type still has many adherents. There is, in fact, much to be said for the semaphore type when it is realized that the lighting codes vary throughout the world. In Britain, we have an amber direction indicator and red stop and tail lights; in Europe use is made of an amber direction indicator and stop light and a red tail light; and in the U.S.A. a red direction indicator, stop light and tail light are employed. It was possibly for this reason that on the new Vauxhalls the rear direction indicators are well separated from the tail lights.

It was only to be expected that Lucas would exhibit, in addition to their three flashing indicator sets, the latest SF 80 flush fitting and SE 100 external mounting types of semaphore direction indicator, both of which have replaceable arms. In passing, it is interesting to note that Creators Ltd. exhibited the Plansel flashing trafficator set which is available in 6- and 12-volt types. This set consists of automatic control unit filaments enclosed in special tubes designed to fit all standard semaphore types of direction indicator without recourse to rewiring.

The well-established Lucas high-note and low-note model WT 614 Wind-Tone horns have been redesigned and are now known as the Model 618 They are now fitted to the majority of popular British cars. Although the current consumption of the new horn is slightly greater than that of the previous model, the note produced has been made louder, sharper and clearer. These horns can, of course, be installed singly or in matched pairs. Other established Lucas horns of interest were the Model WT 616 Herald Wind-Tone units. Introduced originally for coaches and overseas touring, they are being increasingly used by small marine craft and river launches. They are also in regular use as competitor's warning signals at race meetings.

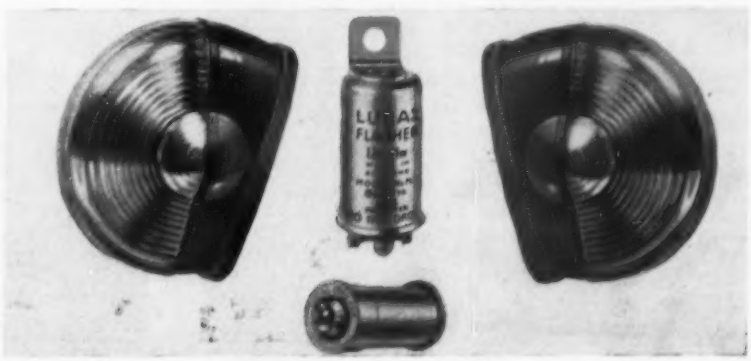
A recent addition to the well-known range of Marchal horns is the Stidor—a light-weight instrument with a strident note, particularly suitable for light, fast cars. It has an electro-compressor measuring only 5·25 in × 2·6 in (130 mm × 65 mm), a single trumpet of 10·6 in (270 mm) length and the complete assembly weighs only 5 lb 1 oz (2·3 kg). It is available for 6-, 12- or 24-volt circuits.

Windscreen wipers and washers

It was gratifying to find increasing application of the two-speed self-parking twin-blade type on both British and Continental cars. American manufacturers continue, for the great part, to favour the variable-speed self-parking twin-blade type. On most cars the sweep of the windscreen wiper blades has been increased. This is another long called-for improvement leading to a better range of vision and greater road safety. Much, however, has yet to be done to improve windscreen pillars. In many cases the pillars are still much too wide. They should be of a width no greater, and preferably slightly less, than that between the driver's eyes. Excellent examples of improvements in this direction were found on the Daimler One-O-Four and the Vauxhall range.

Also gratifying was the increasing application of windscreen washers, a good example of which was shown on the Wolseley stand. But the main attraction in this field was the new Lucas washer called the Screenjet. This is the first electrically-operated unit to be included as initial equipment by a British motor manufacturer. It is generally available to the trade and simple to fit. The main components are a motor-driven centrifugal pump and a glass container, the assembly being well supported in a carrier mounted in the engine compartment. The jets are supplied through tough transparent tubing and issue from a single twin-hole nozzle, or from two single-hole nozzles either on the scuttle or in the wiper arm bearing boxes.

On the latest Vauxhall cars, the rear flashing indicator on each side is amber-coloured and well separated from the tail and stop lamps



This Lucas flashing direction indicator set comprises two independent single-pole, Model 1559 lamps, with amber lenses, a Model F13 flasher unit and a WL12 warning lamp

Control is by a simple push-button on the instrument panel or facia and the only action required to bring the unit into operation is a momentary finger tip pressure on the push-button. Subsequent operation and switching off are entirely automatic. In this way, there is little, if any, distraction to the driver.

When in action, the Screenjet provides two strong streams of water which play upon the windscreen for about seven seconds. This can be repeated for a further thirty operations before the container needs refilling. The container, incidentally, has a capacity of approximately two pints, and is filled only with soft clean water, no special cleansing fluids or solvents being required.

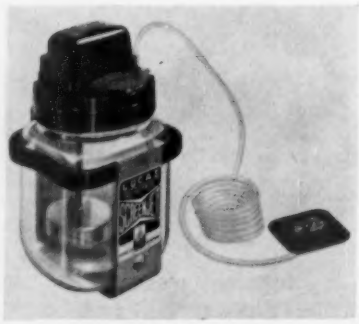
Ignition and Accessories

There were items of interest covering the whole field of ignition, but they were in no way revolutionary. Ross, Courtney & Co. Ltd. exhibited a new streamlined Petromag safety lock designed to turn off the petrol and switch off the ignition simultaneously. Another aspect of switch application could be seen on the Sunbeam Rapier, the engine of which can be started simply by turning the ignition key.

AC-Delco Division of General Motors Ltd. showed a British-made oil-filled coil together with its sealed block and orange packaging. A fluid-filled coil, incidentally, is fitted to the M.G., Series M.G.A., the ignition system of which is suppressed against radio interference. Creators Ltd. showed water and moisture proof flexible distributor cap covers for 4- and 6-cylinder engines. On the Ford Mercury and Lincoln stands there were vented dual vacuum-controlled units, with single rocker arms; these are for 8-cylinder engines and are fitted with weather proof L.T. and H.T. wiring. Lucas displayed an improved version of the Model DM 2 distributor head which is fitted to many popular four-cylinder cars. It is claimed that the flexible distributor cap cover eliminates most, if not all, of the troubles arising from vehicle exposure in wet and wintry weather, car washing and from condensation. For the dual vacuum-controlled distributor head the claim is that it meets the needs of a high compression engine and responds to rapid acceleration, thereby eliminating power lag. Of the two vacuum units, one is smaller than the other and each unit is fed separately. The smaller one is located immediately behind the other.

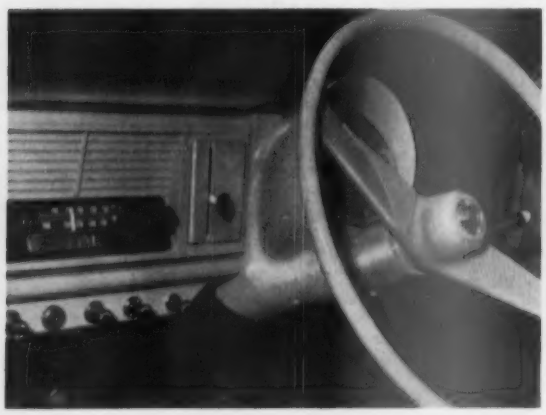
The latest Model DH 2 distributor has been equipped with an improved contact breaker assembly in which friction is almost eliminated by re-directing the line of action of the clamping and contact spring. A further reduction in hysteresis has been effected by using a flexible spring link between the vacuum unit and the contact breaker plate, in place of the original pivoted link arm mechanism. Other modifications include the introduction of a simple screwdriver adjustment locked by a single screw, for the contact breaker gap, and the fitting of an improved metallized paper condenser with its electrical connection resistance-brazed to a central watertight stud.

On the Ford Mercury and Lincoln cars, 18 mm sparking plugs are employed. For these the claim is made that they are specially designed for high compression engines in that, having an ample annular space surrounding the insulator and electrodes of new composition, they are anti-fouling. This is said to give 100 per cent longer life and much longer periods between cleaning. In view of this, it is particularly gratifying to note that both K.L.G. and Lodge exhibited improved versions and wider ranges of their renowned platinum-pointed sparking plugs. Because platinum has a high resistance to corrosion and erosion, the plug's life is greatly increased and longer periods of operation without attention are possible. Much smaller electrodes which cool off more rapidly after firing, can be used; this reduces the risk of pre-ignition under high duty conditions. These plugs can be run at higher average temperature, thereby increasing their resistance to fouling. As a result, the entire heat range is extended, and one platinum-pointed plug operates satisfactorily under conditions requiring two heat values of normal type plugs.



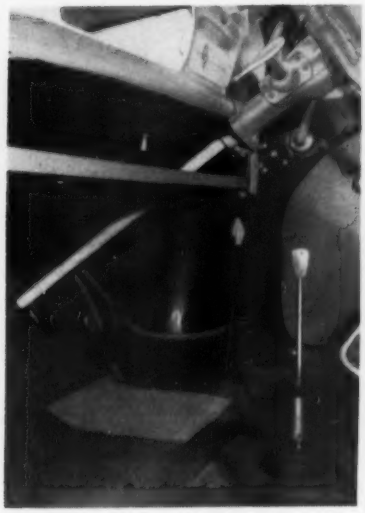
Lucas Screenjet, the first electrically-operated windscreen washer to be included as initial equipment by a British motor manufacturer

In the application of accessories, the Countryman adaptations by Harold Radford (Coachbuilders) Ltd. for the Rolls-Royce Silver Cloud and Bentley S series saloons stood supreme. Among their many accoutrements were a Remington 12-volt electric kettle and razor, a Pivophare swivelling fog lamp and a Grundig Stenorette tape dictating machine. The kettle is operated from a point in the nearside of the luggage boot, and the razor from a point on the facia panel. The dictating machine operates at standard voltage, 230 volts A.C., for use in the home, office or car, and its power pack, specially designed to fit under the luggage boot floor, is completely concealed. When not in use, the machine itself is carried on the rear parcel shelf. It can be used from either of the rear folding tables, and is supplied complete with microphone. A plug-in cable is provided for connection to the power supply points on the nearside of the rear seat heelboard, and a 12-volt vibrator in the power pack converts the car's 12-volt D.C. supply to 230-volt A.C. for the operation of the recorder.



The simple control for the heater on the Standard Super Ten. A cowl is incorporated over the dial for the speedometer and fuel gauge

On the Rolls-Royce Silver Cloud, the two knobs to the left of the ignition switch are for windscreen demisting and defrosting, while those on the right are for heating and ventilation



In the Renault 750, the lamp switch is on the steering column

Cigarette lighters are being installed more and more in cars of all kinds. A particularly pleasing application in this direction was to be seen on the Wolseley Six-Ninety. On the Smith's stand was shown a new lighter which, it is claimed, cannot be burned out by mis-use. The complete knob assembly, including the element, is pressed home in the cover, thus making the circuit for the element to heat up in the usual way, but the sides of the case incorporate stops to prevent the element from being pushed in further than is necessary for contact to be made. The contact takes the form of a bi-metal claw which is released automatically when the element reaches its working temperature. Even if the knob assembly is held in place, despite the instructions to the contrary, the circuit will be broken as soon as the bi-metal strip expands. Lighters and similar gadgets have been popular for some time in the United States, and are fitted as initial equipment in many American cars.

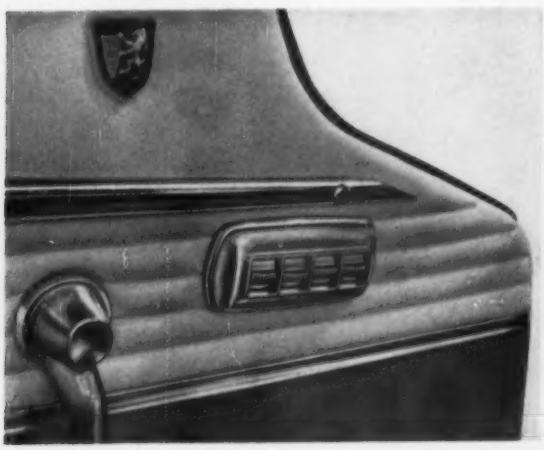
Controls and Instruments

There was a marked improvement in controls in general, with regard to appearance, grouping and accessibility. A typical example is the Austin A50 Cambridge. Other good examples in the small and medium-sized British cars were to be seen on the Ford Prefect de Luxe, the Standard Super Ten, and the Vauxhall range. On the Ford car there are only two instruments, a combined fuel and temperature gauge with ignition warning lights at three o'clock, and a speedometer incorporating the main beam warning light at six o'clock. The dials of both instruments are of a diameter approaching the full depth of the facia panel, and they are located one on each side of the steering column. There are only three pull switches, and the heater controls take the form of two quadrant levers, one for defrosting and the other for interior heating. The simplest heater control to be seen was that on the Standard Super Ten. It is a single lever control on the facia panel near the steering column, and is both elegant and easy to reach. Similarly situated, but having two levers, is the heater control of the Vauxhall range.

Of the large cars, the Daimler One-O-Four and the Rolls-Royce Silver Cloud were outstanding, even if a little conservative. On the Daimler, all the controls are clearly marked, not by symbols but by their full titles—a real advantage. Its defrosting and heater controls are located just below the adjustable steering column. On the Rolls-Royce there are two defrosting controls and two interior heating controls. They take the form of thumb-screws, pulling out for air and water flow and turning for blower speed. Each has two pull-out positions, and thus the regulation they provide can be graduated to a nicety. On the Chrysler New Yorker each control, when operated, becomes illuminated translucently. This is particularly advantageous where an automatic transmission is employed.

A heater duct discharge orifice is incorporated in the heelboard of the Renault 750

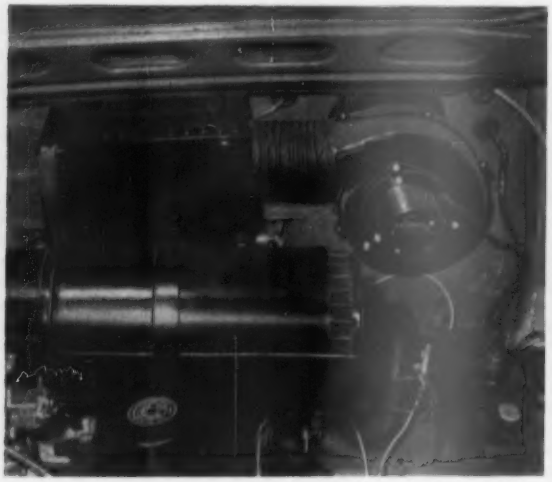
Electric clocks and temperature gauges are gaining in popularity; in most, the digits are clearly defined. Two good examples of clarity are those on the Morris Isis and the M.G. Magnette. On the Morris all the instruments are readily legible from the driving position; on the M.G., the clock is mounted above the windscreen, in full view of all the occupants. It was, no doubt to meet the increasing demand for electric temperature indicators that Smith's exhibited a new unit of this kind. It consists of an indicator for dashboard mounting, and a transmitter in a brass bulb for fitting in either the cylinder head or the radiator header tank. A single wire connection is employed between these two units. The transmitter contains a temperature-sensitive resistance which has a very large rate of decrease in resistance as the temperature rises. This variation in resistance causes variation in a magnetic field in the instrument which is followed by a soft iron armature carrying the pointer. A feature of this indicator is that its pointer returns to the "cold" position when the ignition is switched off.



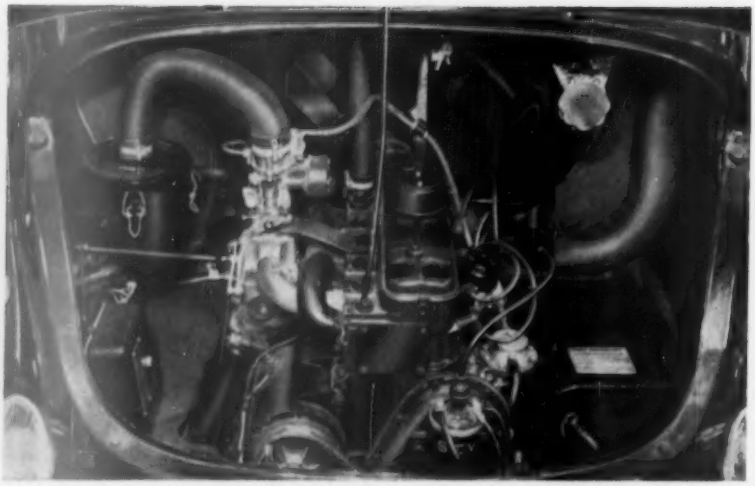
Left, four-switch master control for all windows; right, the twin-switch control for the driver's seat of the Chrysler New Yorker

Left: The Key-Leather car heater, together with its controls, ducts and demister nozzles

Below: The heater installation on the Standard Super Ten. On the scuttle can be seen the adjustable air intake, and the water circulation control valve is readily accessible in front of the heater unit



Above: In the Standard Vanguard, the heater and blower are mounted separately on the dash and the air intake is on the scuttle



Right: Hot air for the interior heating of the Renault 750 is taken from the engine radiator. The duct through which it passes can be seen on the right of the engine compartment in this illustration

Chassis and body units

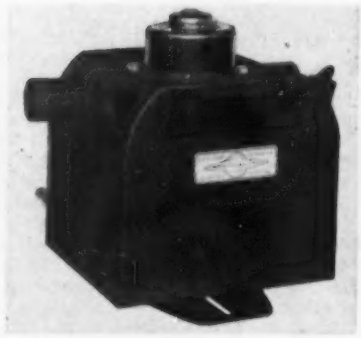
In this field there were three types of magnetic clutch, two types of overdrive, one type of suspension unit, a few types of driver's seat elevator and inclinator, and several types of window wiper. Among the clutches was a completely new unit, known as the Elexmatic-Transmittor, manufactured by Helecs Vehicles Ltd. Control of the clutch and accelerator is effected by one pedal. The normal current consumption of this unit is only 3 amps and, it is claimed, it will operate satisfactorily at less than 1 volt. As a result of its application to a Morris Minor, a fuel consumption of 55-60 m.p.g. is said to have been obtained. This, and the estimated quantity production cost, for units of normal size, of about £10, to the car manufacturer, makes the unit particularly suitable for the average small car. Clutch engagement is effected smoothly through the medium of an arrangement consisting of a solenoid, a piston and cylinder with an air intake bleed valve, and an electrical resistance. This action, in being linked with the accelerator, is progressive. An additional solenoid serves to lock the gearbox selector rod in the gear selected until the solenoid is de-energized by clutch disengagement action.

Examples of driver's seat elevators and squab adjusters were to be seen on the Chrysler New Yorker, Ford Mercury and Lincoln cars. Easily reached twin-switches on the side of the seat, set in motion a compound wound motor which, acting through a worm gear and appropriate bell-crank lever and parallelogram links, adjusts the elevation of the seat pan and inclination of the squab.

Good examples of electric window winders are those on the Chrysler New Yorker. In addition to a switch on each door, there is a multiple master switch on the driver's door by means of which he can operate all the windows. Each door contains a shunt motor which, through the medium of a worm gear and a conventional window operating mechanism, raises or lowers the window as required. In the British examples, notable among which were those on the Armstrong Siddeley Sapphire and Daimler One-O-Four, the motor in each door operates a counterweighted chain mechanism. The motor is made by the Commercial Ignition Co. Ltd.

Heaters and radios

It was gratifying to find that not only is increasing use being made of heaters and complete air conditioning systems on British cars, but also that the manner of their installation has considerably improved. They now look as they should—part of the car. Even many of the smaller cars had heaters fitted as standard, or were arranged for heater fitment as an optional extra. That heaters have come to stay is evidenced by the air intake arrangements of the Austin A50 Cambridge, the Standard Super Ten and the Vanguard III. The Cambridge has air intake grill on the top of the bonnet, a position which, owing to its shape, causes it to look like the top of a traditional Austin radiator when seen from the driving seat. The Vanguard has an adjustable flap above the scuttle. Both have a chromium plated grill in front of their intake.



This standard heater unit manufactured by Delaney Gallay Ltd., is called the Good Companion

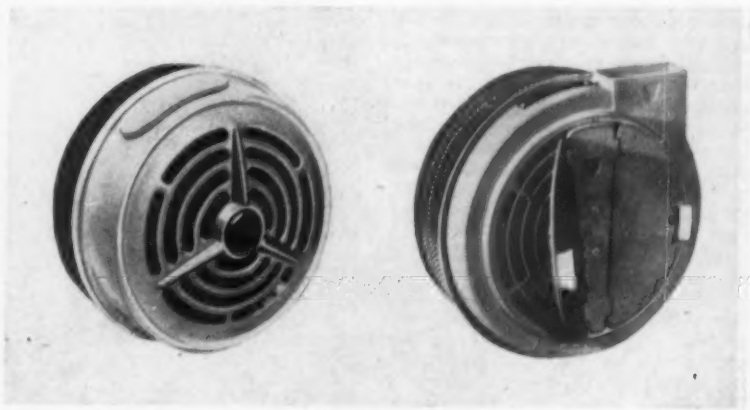
The system of heating and ventilation on the Rolls-Royce is interesting. It is of Rolls-Royce design and has two air intakes, one each side, which supply the front and rear body compartments respectively. Moreover, the valves controlling the air and water are operated by vacuum units, and a full width windscreen demister slot is employed.

Some new heater units were exhibited by Delaney Gallay Ltd. Among these was the A19 heater designed for installation on the Ford Popular, where it can be readily mounted on the radiator header pipe. There was also the Ranco valve which provides fully automatic temperature control inside the saloon. It has long been used in conjunction with vehicle heating in the U.S.A. and Scandinavia, and is now being manufactured in this country. This valve is available as an optional extra with any heater.

New in the K-L range of products exhibited was the K-L 502 heater, a compact unit incorporating the heat exchange matrix, blower fan and motor in a single casing, 10 in × 9½ in × 6½ in. It is supplied in three output styles: 3, 4 and 4½ kW.

The well known Smith's 3½ kW fresh air heating and ventilating system continues to be fitted to many British cars. Coming into use for original equipment purposes is a new Smith's 2¾ kW heater. In this, the blower, with the air intake, and the heater radiator are in the same unit measuring 16½ in long × 10½ in high. The blower and all water connections on the unit body are reversible, so considerably facilitating fitting on either side of the vehicle. Added to the range of Smith's recirculatory heaters are the Junior, of 1½ kW capacity, for small cars, and the Senior, of 2¼ kW capacity for large cars. These heaters are for vehicles in which there is no provision for fresh air heating, or when the additional cost of such heating is not considered justified. An extra refinement for recirculatory heaters is the Heater Temperature Control. This consists of a metering water valve with a push-pull control on the facia panel. It varies the flow of water through the car heater matrix, and consequently, governs the temperature of the air from the heater.

Ekco have added two more radios to their standard CR152 range, of which one, unlike other Ekco models, is for 6 volt battery operation. Philips, too, have added a new model, known as the MotoRadio, to their range. It can be fitted easily into the space provided for radio on most British cars, and although designed primarily for 12 volt operation, is readily adjustable to operate at 6 volts without changing the vibrator or dial bulb and without the use of a soldering iron. It has built-in suppressors, and weighs no more than 6 lb 11 oz, excluding speaker. Radiomobile, of course, is a popular make for British cars. The latest type has push-buttons that can be reset almost instantly when driving from one region to another, and is offered as an optional extra.



Two Smiths recirculatory car heaters. On the left is the Junior model, with a heat output of 1½ kW, and on the right is the Senior, which has an output of 2¼ kW

ACCESSORIES

Further Progress Shown by New Designs of Chassis Components and Equipment

DURING the past twelve months manufacturers of car accessories, equipment and components have again made substantial contributions to the improved efficiency, economy, safety, comfort and appearance of modern cars of all types. They are also entitled to a large share of the credit for the current high standards of performance, reliability and durability that have been attained. Though the latest products of these manufacturers were well represented on the vehicle exhibits, many could be examined in greater detail on their own stands, and reference is made here to a selection indicating some of the directions in which progress has been made.

The advantages of supercharging have been well demonstrated by performance tests on a number of cars of different makes and sizes fitted with the Shorrocks superchargers, as supplied by Rubery, Owen and Co. Ltd. This company will shortly introduce a new range of units suitable for both petrol and diesel engines up to 14 litres capacity. The units will be of a modified design: the drive to the drum, instead of being direct as at present, will be by a gear wheel on a central main shaft engaging with an internal gear ring at one end of the drum, with either a step-up or step-down ratio, according to the requirements of the conversion. The main shaft will also be extended so that it can be used for driving auxiliaries.

Of quite a different design is the new Wellworthy-Ricardo piston type of supercharger, developed for diesel engines. Its air delivery varies from 85 ft³/min at 1,000 r.p.m. to 350 ft³/min at 3,500 r.p.m. Wellworthy Ltd. state that by fitting this supercharger to an engine of 5·75 litres capacity, the power output can be increased to that of a normally aspirated 9 litre unit.

This supercharger has two banks of cylinders with double-acting pistons actuated by a single non-rotating wobble plate mounted on ball bearings. Each bank of cylinders is grouped axially around a single central rotary valve, which controls in turn both inlet and delivery to and from the ends of each cylinder. The wobble plate reciprocates the piston rods directly, through spherical connections. These rods are carried in long guides which centralize them so that the pistons do not make contact with the cylinder walls; instead, the small clearances round the pistons are sealed by labyrinth grooves. This eliminates the need for piston rings. Since the cylinders are not subject to wear, they are made of a light alloy.

A number of superchargers of this type, fitted to diesel engines of commercial vehicles, have been undergoing service tests, the results of which are awaited with considerable interest. Of one, installed on a Leyland Comet, it is stated that the fuel consumption has been improved from 13 to 18 m.p.g., and over a distance of 50,000 miles a fuel cost saving of £160 has been obtained.

Since its first appearance at Earls Court last year, the Perkins P6(C), six-cylinder diesel engine has been put into production for the Humber Super Snipe Mk II and Mk III cars. With a back axle ratio of 3·4 : 1, the cars equipped with this engine are said to have a top speed of 86 m.p.h. The fuel consumption claimed is 28 to 36 m.p.g.

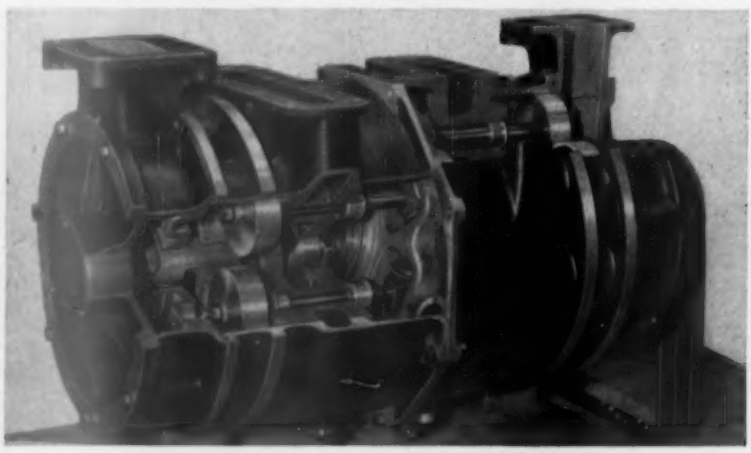
This year, a series production engine modified for installation in private cars, was exhibited on the Perkins stand. The water pump is now in line with the fan and, together with the dynamo, is belt-driven. A lighter flywheel is fitted and a damper is added to the front end of the crankshaft. To obtain quieter operation, the internal diameter of the fuel pipes has been reduced to 1 mm, as compared with 1·8 mm, for the standard engine. The atomizer pressure is now 100 lb/in² instead of 125 lb/in², and the fuel pump has been recalibrated to give an engine output of 88 b.h.p. at 3,000 r.p.m. The weight of the engine, without the flywheel and its housing, is 686 lb. The Perkins P4(C), four-cylinder model is available for Austin and Morris cars as well as for the Land-Rover and others. It has an output of 60 b.h.p. at 3,000 r.p.m.

The Sheepbridge Oil Saver piston rings, made by Advance Motor Supplies Ltd. and exhibited by Sheepbridge Engineering Ltd., are designed to overcome excessive oil consumption in worn cylinder bores, to eliminate piston slap and to reduce friction and bore wear. They are intended for fitting in the scraper ring groove above the gudgeon pin. Each ring assembly comprises two plain, flat steel segments, between which is a steel spacer ring of fluted section. Inside these is a steel expander ring. When inserted in the piston groove, the spacer presses the segments against the sides of the groove, while the expander presses them outwards against the cylinder wall, giving complete sealing.

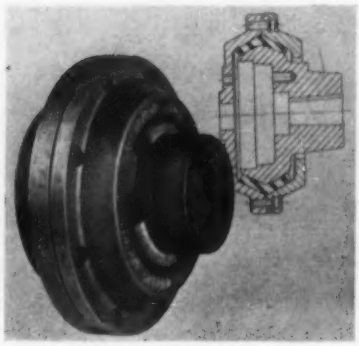
Though chromium plated piston rings have long been employed to reduce cylinder bore wear, the plating of scraper rings presents a much more difficult problem because of their complex section. Plating of these rings, however, has been successfully accomplished by Bricovmo Ltd., who exhibited examples on their stand. In the unplated condition, owing to their small face-width, these rings are liable to more rapid wear than the wider compression rings, but when they are plated their life is materially extended. The production of plated rings has to be carried out with greater precision than is necessary with the plain type, since they take considerably longer to bed down to the cylinder walls.

The same company have introduced a new range of swirl chambers intended particularly for use in indirect injection diesel engines of the Ricardo Comet type. These chambers are machined out of Bricrome heat-resisting iron, containing 30 per cent chromium, and have proved very successful fitted to the small Standard diesel engines as installed in taxicabs.

The Glacier dry bearings shown by the Glacier Metal Co. Ltd. have been produced specially for applications where oil is difficult to retain, or is



In the Wellworthy-Ricardo supercharger, the pistons do not touch the cylinder walls and the clearances between them are sealed by labyrinth grooves



Metalastik Bicone coupling for marine propeller shafts

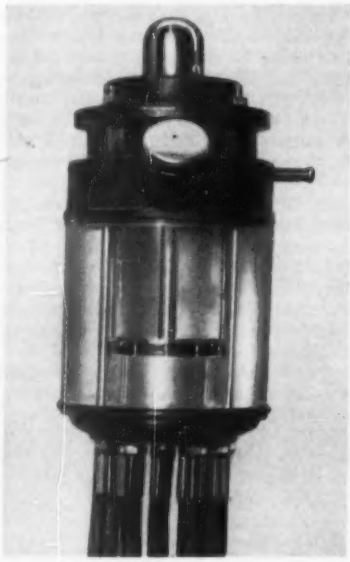
undesirable, or where conventional bearing materials would suffer from the effects of corrosive liquids. Available either as bushes or thrust washers, they consist of a steel backing lined with sintered bronze impregnated with polytetrafluoroethylene, PTFE, a plastics material with an unusually low dry coefficient of friction.

This property was demonstrated on the company's stand by a pair of swinging weights attached to two steel journals, one supported between two plain lubricated white-metal half-bearings and the other between dry half-bearings of the Glacier, dry type. When both weights were set swinging, that carried by the white metal bearings stopped considerably earlier than the other. After a PTFE-lined bearing has been in operation for a short time, the working friction tends to be further reduced, as compared with its initial value, since some of the PTFE is transferred to the surface of the journal with which it is in contact. On no account must the bearing surface be machined—this would remove the PTFE, on which its low friction qualities depend.

The Metalastik Bicone coupling, specifically designed for use in the transmission shafts between the power units and propellers of motor vessels, is a recent addition to the many and varied applications of rubber to absorb vibration and permit movement without wear, friction or the need for lubrication. By absorbing torsional vibrations, in the transmission between the engine and propeller, which react on the hull through the engine and its mountings, this unit adds greatly to the comfort of passengers. It also allows the engine to move on flexible mountings without over-stressing the propeller shaft or overloading the stern tube bearing, provided the nearest bearing is a reasonable distance from the coupling or a second coupling is employed. This unit also smooths out torque fluctuations on the reduction gears, thus increasing their working life.

The periphery of the centre, or driven, component is of double-conical section. A rubber ring of similar section is bonded to its outer surface. Round this is a two-piece outer, or driving, member the halves of which are bolted together to compress the rubber. Safety stops are incorporated so that in the event of damage to the coupling, the drive is still maintained. The coupling will transmit a torque of up to 500 lb-ft and withstand end loads of up to 3,000 lb. It can accommodate a maximum angular misalignment of 1½ deg.

Newton and Bennett Ltd. have introduced a cross-valve type of telescopic, hydraulic, suspension damper. This unit has bottom valves of new design, which improve the fluid flow condition and therefore the volumetric efficiency. They do this by giving a more direct line of flow for the fluid. An additional advantage is that the response to axle movement is more precise and immediate. The function of the bottom valve is to control the flow of fluid passing out of the inner



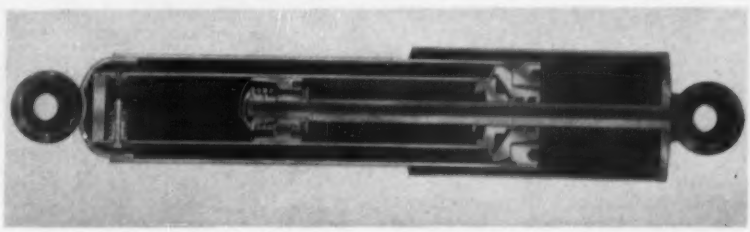
Clayton Dewandre vacuum-operated, 12-point automatic chassis lubricator

cylinder during the downward stroke of the piston, that is, when the wheel rises over a bump on the road. This valve is of the conical type and is held, by a coil spring, on its seating in a hole in the wall of the cylinder.

On the rebound stroke, fluid enters the lower end of the cylinder through the recuperation valve. This valve is a thin flexible strip of spring steel, backed by a ribbed plate. It is loaded by a strip steel spring held under the head of a split pin that locates the whole assembly, and it covers two large holes in the cylinder wall. Thus, it allows the fluid to enter freely but, to avoid the effects of incomplete filling, it shuts rapidly when the piston movement stops.

The ability to adjust the damping of a car's suspension system from the driving seat is a refinement likely to meet with a growing demand, if its benefits are not discounted by liability to derangement or need for frequent attention. Such shortcomings do not appear to be possessed by the latest types of remote-controlled dampers to make their appearance. Said to be the first telescopic damper of this type to be put into full production, the new hydraulic Telaflo Ride-Control unit has been developed by Universal Dampers Ltd. in conjunction with Armstrong Siddeley Motors Ltd. It is at present available only as an optional extra on the Armstrong Siddeley Sapphire, or as a replacement on existing cars of that type. It is controlled by a knob on the facia. This knob can be turned in a clockwise direction to stiffen the suspension for fast driving, or anti-clockwise for driving in town or over bad roads. Between these extremes, an infinite range of ride control is obtainable by the driver. A new feature of the unit is its extra large capacity, lower working pressure and more effective cooling. It also incorporates an air sac in the recuperation chamber to eliminate frothing or aeration; this also allows it to be operated in any position.

Also designed for remote control is a new model of the Andre telescopic damper, basically similar to the well known friction type supplied by Andre (Components) Ltd. Damping effect is afforded by movement, against friction and the pressure of a coil spring, of three piston type shoes faced with oil-impregnated hardwood. In the previous model, adjustment was effected by turning the outer skirt tube to vary the compression setting of the coil spring, which is contained in the hollow central rod to which the shoes are fitted. Now, adjustment is made by varying hydraulic pressure at the top of the cylinder, which is connected by a pipe to a hydraulic control cylinder on the facia. A knob control is fitted to this cylinder, and is turned to adjust the damping.



A section through the Newton and Bennett shock absorber, showing the modified bottom valve

Chassis lubrication is not only the most important of all servicing operations, but also is a somewhat irksome and lengthy task if performed with an oil or grease gun. It is surprising, therefore, that more advantage is not taken of the fact that it can be done automatically.

That the lubrication equipment need not be elaborate or difficult to install and that it does not need frequent attention is shown by the simple design of the prototype automatic lubricator developed by Clayton Dewandre Co. Ltd. This unit consists of a cylindrical oil container, of one pint capacity, made of transparent plastics material to show the oil level. Mounted on the top of the container is a vacuum cylinder and piston, connected by a pipe line to the brake servo system of the vehicle. The vacuum-actuated piston carries a central rod fitted at its lower end with a piston plate which operates twelve spring-loaded plungers. Each plunger cylinder is connected by a $\frac{1}{4}$ in bore pipe to a chassis lubrication point, to which it delivers independently a maximum shot of 0·025 cm³ of oil. The quantity of oil delivered to each point can be varied by an adjusting screw.

Styling of the front ends of many of the latest types of private car imposes restriction on the height, and therefore the cooling area and water capacity, of the radiator. To overcome difficulties thus introduced, another design of radiator has been developed by the Coventry Radiator and Presswork Co. Ltd. Known as the Crossflow unit, this radiator differs from those of normal types in that the finned tubes are arranged horizontally between two side tanks. The overall width and capacity are thereby considerably increased without detriment to the appearance, as shown by the exhibited example intended for a Vanguard.

COACHWORK

Few Major Developments but Many Detail Improvements

IT was not expected that there would be anything startlingly new in body styling or construction. For some time it has been evident that manufacturers have now established a general line of development around which all changes are centred. It is, for example, quite clear that the wing, which was an entirely separate component, whether at front or rear, is now designed as an integral part of the body, the only variation being whether the wing maintains a full width throughout its complete run, its upper line being also slightly varied.

The new models showed that the unitary method of construction has found further adherents. It is also apparent that weight reduction has been closely studied. Individual coachbuilders, of course, can play little part in the developments of unitary construction, but in the matter of saving weight in wing design, such firms have played a most important part. This undoubtedly will continue to persist in all aspects of body development.

It is, however, difficult this year to focus attention on any aspect of body-building technique that can be said to represent a pointer towards the ultimate building or design methods. In general, new ideas were confined mainly to minor improvements, of which the safety strap may be cited as one example. It is early yet to say whether such an idea is likely to find wide approval, but it should be possible in the ensuing months to determine whether public appreciation demands the extension of the idea. Such is the excellence of modern standard productions that the special coachwork to be found in the coachbuilding section was mainly confined to the larger more expensive chassis. Modifications that have been made to the Bentley and Rolls-Royce range during the past few months have had a noticeable effect on coachwork mounted on such chassis.

The Rolls-Royce Silver Cloud and the Bentley 'S' chassis are from a coachbuilders viewpoint, very similar. It may perhaps be of interest to refer to some of the chassis features affecting the coachbuilder, since it is for these two chassis that much special coachwork is built. From a technical viewpoint, particular interest attaches to the method adopted for mounting the body. As in the past, the coachwork is isolated from the chassis by Silentbloc bushes, so disposed that support is given at pillars and wheel arches. On occasions, depending upon the type of body mounted and largely determined by the nature of the roof, whether of solid panel or convertible type, it is found necessary to ignore the floating mountings and attach the body rigidly to the chassis.

Particularly for isolation mounting, a scheme has been devised whereby a system of controlled jacking under freely mounted bushes enables the bushes to be tightened to give an even distribution throughout the mounting of the body. This ensures that every bush is correctly aligned and carries its appropriate share of the load.

Complete chassis re-arrangement has taken place and coachbuilders will appreciate the absence of rivets in the construction of the chassis frame, which is now welded. Previously it was occasionally found that the projecting rivet head reduced vital clearance, with the result that subsequent fouling produced noise. All these changes apply equally to both standard and Continental chassis, and some excellent examples were to be seen.

H. J. Mulliner and Co. Ltd. in their Continental saloon model, have increased the distance between the front and rear seats by 2 in, while the width between the rear seat arm rests is $3\frac{1}{2}$ in more than in the original model. The re-arrangement of the seating has enabled the roof to be lowered by $\frac{1}{2}$ in. A useful feature now incorporated by this coachbuilder is that the rear seat cushion may be folded upwards to give a rear seat pan upon which luggage may be placed. Protection for the heel-board is afforded by a chromium plated strip along its top edge. This is a two-door body with doors hinged on the front pillars; press-button locks are used. For the current model, the curved windscreen is retained and has been still further developed to reduce wind resistance.

The four-door six-light saloon that H. J. Mulliner and Co. exhibited on the Bentley chassis is similar in some respect to an earlier model, in that light alloy construction is employed for the body framework, with panelling in aluminium. In this body, as with so many others, the front wings are continued rearwards at waist height to provide the lower door panels. These wings as they pass towards the rear, are gradually inswept to give a clearly defined rear wing. Behind the rear wheels the rear wings retain their depth to harmonize with the line of the luggage locker, and for both front and rear wings, swaged lines are introduced

Light alloy coachwork by H. J. Mulliner and Co. Ltd. on a Bentley chassis

The Bentley Continental drop-head coupé by Park, Ward and Co. Ltd. has the modern elevated rear wing crown treatment

to relieve the panel depth. The doors close on the central pillars, and to assist front window actuation, triangular panels are provided at the front, these panels being made to swivel for ventilation purposes.

Comfort of the rear seat passengers has received special attention. The seat backs are adjustable, and in addition to the adjustable arm rests on the doors, folding arm rests are embodied in the edges of the squabs. This is a refinement that could be more widely adopted, since it greatly relieves fatigue on long journeys.

Apart from the changes necessitated by the recent Bentley modifications, the two Continental bodies shown by Park, Ward and Co. Ltd. are very similar to those introduced last year. These two bodies are a two-door saloon and a drop-head coupé, which have common lower panels. This coachbuilder always utilizes the full flow front wing, and here again the overall width is reduced as the wing section passes across the doors, giving a clearly defined rear wing outline. In modifying the body to suit the re-designed chassis, the rear panel arrangements have been slightly changed. A fairing on each rear wing now houses the rear lamps and flashing direction indicators, while the luggage locker lid carries the number plate on the back panel. The substantial front and rear bumpers used by this and other coachbuilders concerned with these chassis, are those which are provided by the chassis manufacturer, and modifications to the standard equipment are found less frequently than hitherto.

On the Park Ward drop-head coupé, the head mechanism is manually operated and requires little effort. The head when folded is contained in an envelope cover. In both fixed and drop-head bodies, the rear boot houses the spare wheel and the balanced lid is coupled to a switch which automatically illuminates the boot when the lid is raised. In the design of the lightweight front seats, this coachbuilder has taken the opportunity of incorporating a safety strap, which when not required is stowed in the central recess provided for the folding arm rest. When required for use it is extended across the seat to connect up with a suitable fixing device at the side.

Also exhibited by this coachbuilder were two Rolls-Royce Silver Wraith bodies, both constructed on the well known all-steel method of body frame fabrication, upon which aluminium panels are used. The bodies, which are similar to those produced last year, are of limousine pattern, one seating seven passengers and the other six.

Individual arm rests for the front seat passengers are incorporated by James Young Ltd., in the saloon which was shown on a Rolls-Royce Silver Cloud chassis. This model, and the Bentley sports saloon which this coachbuilder also exhibited, has a light alloy frame panelled in aluminium. The general balance of the designs for both Rolls-Royce and Bentley, is excellent. Full flow wings are used and on the Rolls-Royce Silver Cloud, a raised fairing on the rear wing upper panel gives relief to what would otherwise be a plain uninteresting surface. Following standard practice, the spare wheel is on the floor of the boot where it is covered by a detachable carpet. To get this low position, the chassis manufacturers have adopted a shaped petrol tank which is curved on its rearward face to accommodate a portion of the wheel.

Also shown by this coachbuilder was a long wheelbase Rolls-Royce Silver Wraith carrying a sports saloon body in which the body framework is again fabricated in light alloy with panelling in aluminium. This is intended as a touring limousine and on that account has an electrically operated division window. There is also a capacious luggage boot which carries the spare wheel.

In their Bentley saloon, Hooper and Co. (Coachbuilders) Ltd. have incorporated certain features which are worthy of investigation. For example, to withstand the stresses that are imposed by a fully loaded roof rack, the roof has been specially strengthened to obviate the need for further work should a roof rack be used. In too many cases a purchaser will adopt a roof rack that can impose much undesirable stress on the roof structure, and it is interesting to note that this coachbuilder has anticipated the use of such a fitting.

Another feature of this Bentley saloon concerns the head lamps, which are built into the front wings and are cowled or hooded to prevent the upward glare that can sometimes occur. For

Hooper and Co. (Coachbuilders) Ltd. have incorporated a light alloy framework in this five seater coupé body that they have built on the Daimler chassis

The new 'S' type Bentley, four-door sports saloon, by James Young Ltd., has a built-in electrical demister for the rear window

the body framework, light alloy members are used, panelling being in aluminium. Following the styling which this firm has used for some years, there are no apparent rear wings, the body being sufficiently wide to embrace the rear wheels, to which detachable covers give access. The front wings have a downward sweep and reducing in width, pass over both front and rear doors, of which they form an integral part.

Light alloy body frame construction is also used for the fixed head two-door body which this coachbuilder exhibited on a Daimler DK.400 chassis. This is an unusual body but its lines are undeniably handsome, particularly the flowing sweep of the front wings which extend over the doors to merge into the lower line of the body at the rear of the rear wheels. There are no rear wings, the body panels which are wide at this point, having detachable covers. Also used on this car are cowled head lamps that are built into the front of the wings, in the design of which they form an integral part. The body is lavishly equipped, all-metal fittings, both internal and external, being gold plated. Suit cases are arranged in the boot and there is also provision for stowing camp stools.

On a Silver Wraith Limousine, Freestone and Webb Ltd. displayed a style of body for which they have earned an enviable reputation. The interior of this attractive car well repaid close investigation, for many refinements have been introduced. The layout of the rear of the division is interesting. There is a revolving centre section containing cocktail requisites. This central section is rotated electrically and has a light which automatically switches on when the cabinet is opened. Also in this car is a small occasional seat on the off-side which opens with its back to the door. It is intended for the accommodation of a child, although on occasions an adult could use it. When folded into the division, the underside of the occasional seat provides a convenient foot rest. A similar foot rest on the near side can be hinged rearward to disclose further cocktail requisites.

The Harold Radford Rolls-Royce Countryman saloon is elaborately equipped

There are small reading lights in the quarters. They can be adjusted to a suitable angle at the convenience of the passengers. In the central arm rest a smoker's companion is incorporated in the hinged upper surface, which also contains a mirror that has a universal mounting to permit it to be turned to a convenient angle. A transparent panel in the roof is uncovered when a sliding portion is pushed forward.

In a limousine body on a long wheelbase Rolls-Royce Silver Wraith chassis, this coachbuilder took the opportunity of fitting a 9 in screen television set between the two occasional seats. The set, which is of Ekco manufacture is arranged at floor level, with the viewing screen inclined to enable a clear picture to be had by the rear seat occupant. This body has seating capacity for seven passengers and the occasional seats when folded into the division provide convenient foot rests.

An interesting feature of the Bentley sports saloon shown by this concern is the adjustable mechanism that enables the front seat backs to be raked to any desired angle. The simple control is situated at the junction of the squab and cushion at each side of the car.

Last year considerable interest was aroused by the E. D. Abbott Ltd. conversion of the standard Ford Zephyr body; this idea has now been extended to other models. On a Ford Zodiac a full 74 in can be made available between the back of the front seat and the inside of the rear door. This is effected in the following manner. The front seat is first moved forward as far as possible, and since the coachbuilder has modified the seat slides, the rear of the seat can be lifted until it is approximately 6 in above the floor. It is retained in this position by a security device. It is then possible to fit the detachable rear seat squab to cover the cavity between the front and rear seats, and in this manner the upper portion of a bed is provided. When in position between the seats, the squab is supported by the floor at the front and by a shelf above the rear seat heelboard. This shelf, of course, causes no inconvenience when the car is used normally. The body addition behind the rear doors carries a roof rack in which the spare wheel is mounted when the vehicle is used for camping, but for

Television equipment by E. K. Cole Ltd. is installed in the Freestone and Webb Rolls-Royce limousine

A revolving cabinet houses cocktail requisites in this Rolls-Royce limousine by Freestone and Webb Ltd.

Slender metal door-top frames are used on this Daimler 3½ litre saloon

normal use the spare wheel lies beneath the rear floor.

For many years, drop-head coachwork has been associated with Tickford Ltd. bodies, and its predecessors. To supplement the fixed and drop-head Lagonda cars that this coachbuilder produces in standard form, there is now the Aston Martin DB2-4 Mark II drop-head coupé. This body is constructed of all-steel tube rolled sections for the framework, panelled in 16 S.W.G. aluminium. In the seating arrangements used in this car, it is interesting to note that the rear cushion can be removed to provide a convenient space for luggage on the rear seat pan, and it is realized that this is a type of car in which quite frequently there are only two passengers, the rear seat not being required for its normal purpose. The hood is light in operation and a curved windscreen is used.

Much interest was aroused by a body of Continental construction and design mounted on a 3-litre Alvis chassis. This was a two-door saloon by Graber, a predominant feature being the apparent light construction of the roof. This aspect is enhanced by the metal framed upper door sections and extremely wide curved rear window which leaves a very narrow quarter panel. The wings are carried from front to rear without a break and the line of the bonnet is downswept towards the front to coincide with the wing line. The doors are wide to give convenient access to the rear seats and there is a roomy luggage compartment.

Amongst the production cars, several new models recently introduced showed departures from previous practice, and on that account indicate the trend which manufacturers are following. For example, integral construction is used for the new 2·4 litre Jaguar; the first time that this manufacturer has adopted this principle. This construction has been adopted to obtain a rigid structure of minimum weight. The Jaguar body is interesting in that it follows the general styling of the well known 3½-litre model. The main difference to be noted is that the wing styling follows the full flow treatment in which the upper line of the front wing is carried right through the body, and thus the forward line of the rear wing is absent.

This new Jaguar model is possibly more attractive in appearance than its larger companion, in that the width is not so great, and from all points of view a well balanced appearance is maintained. It is, of course, a four-door body with comfortable seating for five passengers. There is a roomy luggage compartment at the rear, with a balanced lid that is hinged at the top. The spare wheel is stored beneath the boot floor, and the mounting of the petrol tank immediately behind the rear seat squab board gives a low boot floor with freedom from obstruction. The petrol filler tube is taken to the near side rear wing, where it is concealed under a door.

In this all-steel body the absence of a separate chassis frame has made necessary certain reinforcements in the body framing to withstand the loads imposed by suspension units. For example, to strengthen the unit to take the front suspension loads, substantial members extend diagonally from a point just above the wheel centres to the bulkhead structure, whence they are continued by the screen pillars. This method of reinforcement is not new but is certainly a principle to be followed in all cases where unitary construction is under consideration. At the rear, the rear seat pan and rear squab support frame play an important part in resisting loads imposed by the rear suspension, and there is, of course, much stiffness in the floor unit which is reinforced by the rear seat heel-board and a cross member passing from side to side immediately behind the gearbox. Since the floor is low, a central tunnel has been introduced, but this does not detract from the roominess of the interior. All doors are hung on the forward pillars and it is noticeable that no attempt has been made to embody metal frame door tops, for however desirable these may be from the appearance viewpoint, they do present considerable difficulty to the producer, and also have their service problems.

Both front and rear doors have ventilating panels forming part of the windows, and as is becoming normal, the rear door lower panel embraces a portion of what in a normal car would be the rear wing. The curved windscreen has self parking wipers, and a windscreen washer is used. The body is well equipped with walnut cappings and facia, the trimming following the much used bolster style. Since the rear door shut pillars are located well to the rear, it has been necessary to arrange the side rear seat side arm rests on the doors. These arm rests have ash-trays at their forward ends.

The introduction of a new and smaller Armstrong Siddeley Sapphire

Seat straps are fitted in this Bentley Continental drop-head coupé by Park, Ward and Co. Ltd.

In the Ford Zephyr Zodiac by E. D. Abbott Ltd., the rear squab is detachable

model has been awaited with interest, and the new 234 or 236 models show a style of body that represent a distinct departure from the previous Sapphire saloon. The difference in appearance is that whereas the larger Sapphire saloon has well swept lines, particularly in connection with the front wings, the new smaller model employs a wing style that has no comparison on other cars produced in this country. For example, the front wings maintain their high line which passes across the scuttle and on the front doors, but the wing width gradually diminishes until it disappears at the centre pillars. The termination of this rear end of the wing is perhaps too abrupt but obviously it was intended to associate only the front doors with the front wing treatment. The rear wings commence at the central pillars in a horizontal line approximately half way up the door panel. This horizontal line gives a panel of gradually increasing width, which on meeting the normal wing contour is upswept to follow the conventional rear wing line. On account of this wing treatment the body side has a somewhat broken appearance with different levels and angles, confusing the eye, but despite this contradiction of line and possibly assisted by the compact dimensions and general balance of the vehicle, the unconventional wing treatment does not offend.

It should also be mentioned that the swept upper line of the front wing is repeated on the bonnet upper panels which curve downwards towards the front to merge into a low front grille, having a height very little greater than that of the wing nose. The bonnet has a top lid and the bonnet sides are virtually non-existent since they merge into the front wings without any marked depression at the scuttle but gradually increase towards the front, never however reaching much depth.

The windscreen is curved, having self-parking wipers and provided with demisting equipment. A lid in the rear panel gives access to the luggage boot, which has a capacity of 13½ cu ft, the spare wheel being mounted on the floor, where it is covered by a supplementary floor which does not however extend to the full width of the boot. A large rear light having curvature to suit the roof contours is provided in the rear panel, all windows being mounted in chromium plated metal frames.

The new Jaguar 2·4 litre saloon has well balanced lines and is unmistakably a descendant of the Mk. VII model

Particularly interesting is the fact that the body is composed of Hiduminium 22 material, which gives both rigidity and light weight, while its non-corrosive qualities will be appreciated. A further point of interest is that the body is produced entirely within the resources of the Hawker Siddeley organization, for the Hiduminium pressings that compose the body are produced by Armstrong Whitworth, while fabrication of the body is undertaken at the Armstrong Siddeley works.

An unusual rear seat-pan arrangement is used on the Aston Martin DB2-4 Mk II

An unusual rear wing treatment has been adopted for the Armstrong Siddeley 2·3 litre, four-door, four-light Sapphire saloon bodywork, which is basically the same for the 234 and 236 models

Modifications to the Standard Vanguard have resulted in an attractive vehicle (the Vanguard III), which with a wheelbase increased by 8 in gives considerably improved seating as compared with the previous model. The re-arrangement of the seating has enabled the overall height to be reduced and the opportunity has been taken to improve visibility by reducing the size of the pillars, particularly the front screen pillars. Furthermore, the upper door frames are composed of extruded aluminium sections which are anodized for surface protection, rubber sealing strips being introduced between the window channels and the aluminium frames.

The Vanguard III is of unitary construction. The new disposition of seats in relation to the rear wheels now provides much more easy access to the rear seats than was possible on the previous model, the main difference being that the wheel arches no longer encroach upon the rear seat cushion, which on that account has greater width. Furthermore, it is no longer necessary to make provision on the door for the accommodation of the projecting wheel arch panel.

There is the usual curved windscreen, which is matched by the curved back light extending on to the quarter side panels and leaving only a narrow quarter panel between the rear door and the back light itself. Luggage accommodation has been improved and the disposal of the spare wheel beneath the boot floor, with a fuel tank behind the rear squab, gives an unobstructed floor and a compartment having a total capacity of 15 cu ft. Front and rear doors are hinged on the forward pillars and folding centre arm rests are embodied in both front and rear seats; the side arm rests are attached to the doors.

Because it differs in so many ways from the vehicles to which coachbuilders are accustomed in this country, the new Citroën DS19 was the object of much interest. Of the technical features of the body, the door window arrangement is interesting, since only half doors are used, the frameless glasses sealing against soft rubber sections which are attached to the

The shape of the panelling adjacent to the head and tail lamps, as well as the line pressed horizontally across the doors, tends to accentuate the length of the Standard Vanguard III

pillar and roof framing. Only actual use can determine whether this arrangement is satisfactory and bearing in mind the troubles often experienced with the windows of drop-head coachwork, there is some doubt as to whether this arrangement will give lasting satisfaction. However, it has the tremendous advantage that from all seats, the visibility is exceptionally good.

To facilitate access to the front seats, the front door hinge line, which is vertical, is situated at some distance in front of the screen pillar, but with the light door which results from the upper frameless construction, this should not result in door locking troubles. There is a wide curved screen and the roof is composed of plastic panels which have the advantage of reducing weight.

The car has many unconventional features, not the least of which is its frontal appearance, for the bonnet panels are down-swept to a point well in front of the front wheels. It is also interesting to note that the spare wheel is located in front of the radiator, thus leaving all the space within the rear boot for luggage.

The rear door arrangement on the Ford Squire is designed to give the best possible accessibility for stowing luggage

Another new model using unitary construction is the Sunbeam Rapier, which in its two-door saloon form makes a compact and attractive vehicle. Of particular interest is the fact that the bonnet is hinged at the rear, and when raised is automatically held by the spring assistance that is combined with the hinging device. A further point is that the bonnet is released by depressing a handle beneath the front grille.

Comfortable seating is available for four passengers and the rear window embraces both back and quarter panels. The spare wheel is located in a vertical position within the boot, which gives ample accommodation for luggage. From the appearance viewpoint, the main feature is that front and rear wings are united by the intervening body side panel, while it is noteworthy that metal frames are used for the door tops to improve vision from the interior.

The Daimler One-O-One model is an attractive saloon that provides roomy seating accommodation, with a fair capacity for luggage. This body is also one of those in which the upper framing of the door consists of light metal frames and the improvement in visibility from the interior is noticeable. The manufacturers have united the front and rear wings although in this case the front wing does not continue at waist height but has a slightly falling line across the doors to blend with a return sweep into the rear wing midway between the waist and bottom line of the side panel.

Just how much can be done to improve the appeal of the car without modifying the basic structure is to be seen in the latest Vauxhall models, in which several small but important changes have been made. It is obvious that much thought has been devoted to those points which will appeal particularly to the family motorist. In this connection it is particularly interesting to note that press-button locks have been replaced by the conventional type of lever lock with the added safety precaution of a free-wheeling interior handle, that makes it impossible for a child to tamper with the door lock when the car is in motion. This worth-while safety precaution has in ths past been used in connection with external door handles where its purpose was to prevent a car thief from forcing the lock. It is only by exerting a cross-winding action that the free-wheeling device can be overcome. This is not likely to be within the scope of the average child and the latest development should prove effective in preventing accidents.

Another Vauxhall change that presents a reversion to the original specification concerns the use of winding window mechanism in place of the balance fitting that has been used for the last few years. One advantage of this change is that when the glasses are lowered they do not stand above the waist line. On the latest Vauxhall models visibility is greatly improved by increasing the glass area. In the case of the side windows this has been effected by reducing the substance of the upper pillars and door tops. Another point of interest in connection with windows is that to improve rearward vision, a chromium plated guttering is now used above the large curved rear window to carry water away to the side of the body without obscuring the glass.

There is a growing tendency towards the use of two trimming materials of differing texture and colour in the same body. The Vauxhall is an example of the pleasing appearance that can be obtained; Vynide is combined with a vinyl-coated woven fabric for the seats and door trim, while the headlining is in washable Vynide material. The two-colour interior styling is matched by a wide range of external dual colour finishes, which are made possible by the use of horizontal chromium-plated mouldings extending from the front wing to the rear wing and also at a slightly higher level along the upper edge of the rear wing.

Some months ago the Rolls-Royce Silver Cloud and Bentley 'S' series were

Slender windscreen pillars are employed on the Citroën DS19 and the strength of the vehicle is mainly in the sills

Modern styling and streamline form are features of the M.G.A. sports car

announced, and interest was aroused by the styling of the standard saloon made available on these models. This body is of pressed all-metal construction, and before referring to its constructional features, some comparison may be made concerning the marked improvement that has been effected in external appearance. The latest saloon is noticeable for low overall height and modern wing styling. The front wings are extended rearwards to cross both front and rear doors with an upper line that has a downward sweep and an inward taper which gives a full rear wing contour. The overhang behind the rear wheel centre has been increased considerably, giving much improved luggage accommodation. The spare wheel is mounted beneath the boot floor, a single boot lid giving access to both luggage and spare wheel compartments. A low wheel mounting is possible through the use of a shaped fuel tank which on its rearward face follows the line of the spare wheel.

In the interest of weight reduction certain external panel pressings are in light alloy material. They are the bonnet, doors and boot lid. The remaining body pressings are in steel. No timber is used in the construction of the body shell. It is interesting to note that although the Bentley radiator has well rounded shoulders and the Rolls-Royce a distinctly sharp edge at the equivalent point, the scuttle pressings are common to both models. The Rolls-Royce bonnet is so designed that the junction of the side panel with the upper panel grows from a sharp corner at the front to a rounded corner at the rear, the effect being pleasing and making possible the use of a common body.

Additions to the Ford range include two new utility vehicles called the Squire and the Escort. These follow the prevailing trend for the production of utility bodies based on the standard passenger carrying productions. For the convenience of the rear seat passengers, the side windows are made to slide, and for access to the rearward section of the body to carry luggage, the rear panel is provided with two hinged lids, one falling in the manner of a tailboard and the other, which contains the back light, is hinged at the top. Externally, the cars compare favourably with the private models in the Ford range, a horizontal moulding in the case of the Squire, and a side panel swaging in the case of the Escort, continuing the horizontal swaging that commences at the head lamp.

Summarizing the trends apparent in the new coachwork, it is evident that both specialist bodybuilders and car manufacturers have intensified their quest for weight reduction. More frequently it is found that non-stressed panels are composed of aluminium alloy, and it is often found, particularly in the case of a concern having aircraft connections, that the manufacturer has extended the use of light alloys to structural members. In some instances interior fittings such as seats have received attention which has resulted in a worth while saving in weight. Experience shows that the maintenance of seating comfort no longer depends upon traditional methods of trimming and seat frame construction. It has long been known that tension springs provide a convenient basis for cushion and squab construction, their use in the cushion reducing height and consequently head room, which apart from any saving in the construction of the seat itself, can only result in an improved overall figure.

Both interior and exterior colour schemes are brighter, and as previously mentioned, a dual colour scheme predominates amongst standard productions, although less frequently found in specialized coachwork.

There has been no apparent improvement in the provision of space available for luggage disposal, but the scheme whereby the rear seat cushion may be folded out of the way to enable supplementary luggage to be carried on the rear seat pan, has attracted further adherents, particularly on the non-family type car.

Concerning wing treatment, the prevailing tendency is for front and rear wings to form one continuous unit passing across and forming part of the intervening doors, thus giving considerably greater inside to outside dimensions below the waist than above. The space within the panels so provided is put to good advantage in providing pockets and convenient recesses below the ventilating windows, where no provision is required for drop glasses.

As an alternative to the high wing treatment, and found more often on specialized coachwork, the extended front wing falls slightly as it crosses the door panels, of which it forms an integral part. Furthermore, the front wing extensions are inswept towards the rear, making both front and rear wings appear as separate components. These then are the two main wing styles, and while on the subject of wings, it should be mentioned that the practice of forming part of the rear wing on the rear door panel finds increasing use. This arrangement has the advantage that if the rear doors are hinged at the front, the dirty panel surface does not soil the clothes of passengers entering the car.

Closely associated with modern wing design is the question of engine access, and it is found that with the absence of an inner wing valance, the conventional bonnet side panels have virtually disappeared, and access to the engine is had through a hatch on the bonnet top panels. This, unless access is available through detachable panels behind the wheels, is barely sufficient and may on that account add to the cost of the maintenance.

In conformity with the modern trend, horizontal features are accentuated on the sides of the Sunbeam Rapier

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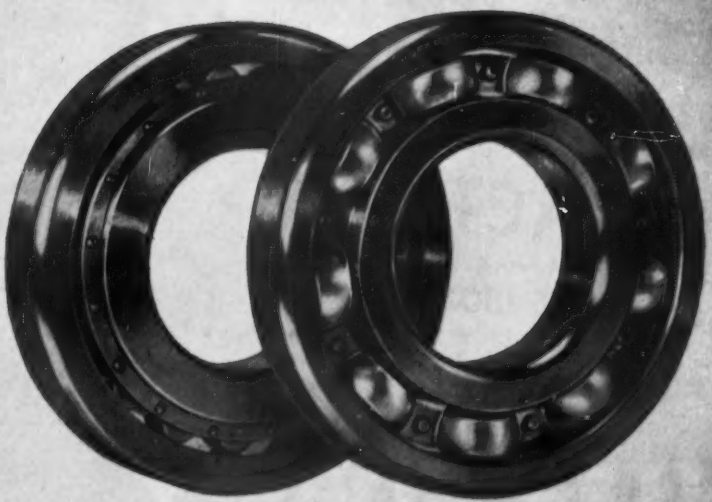

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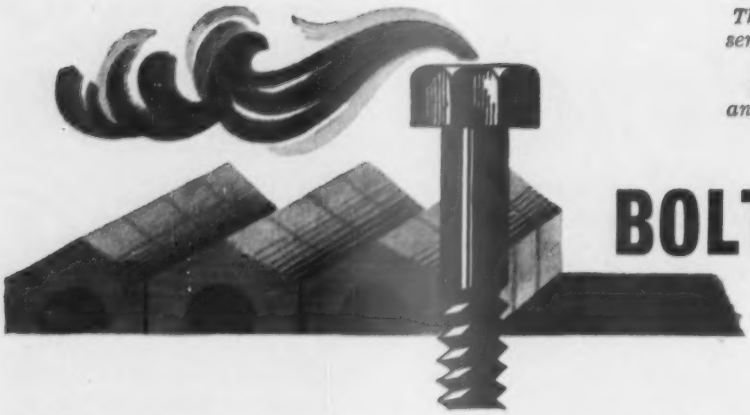

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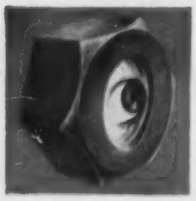

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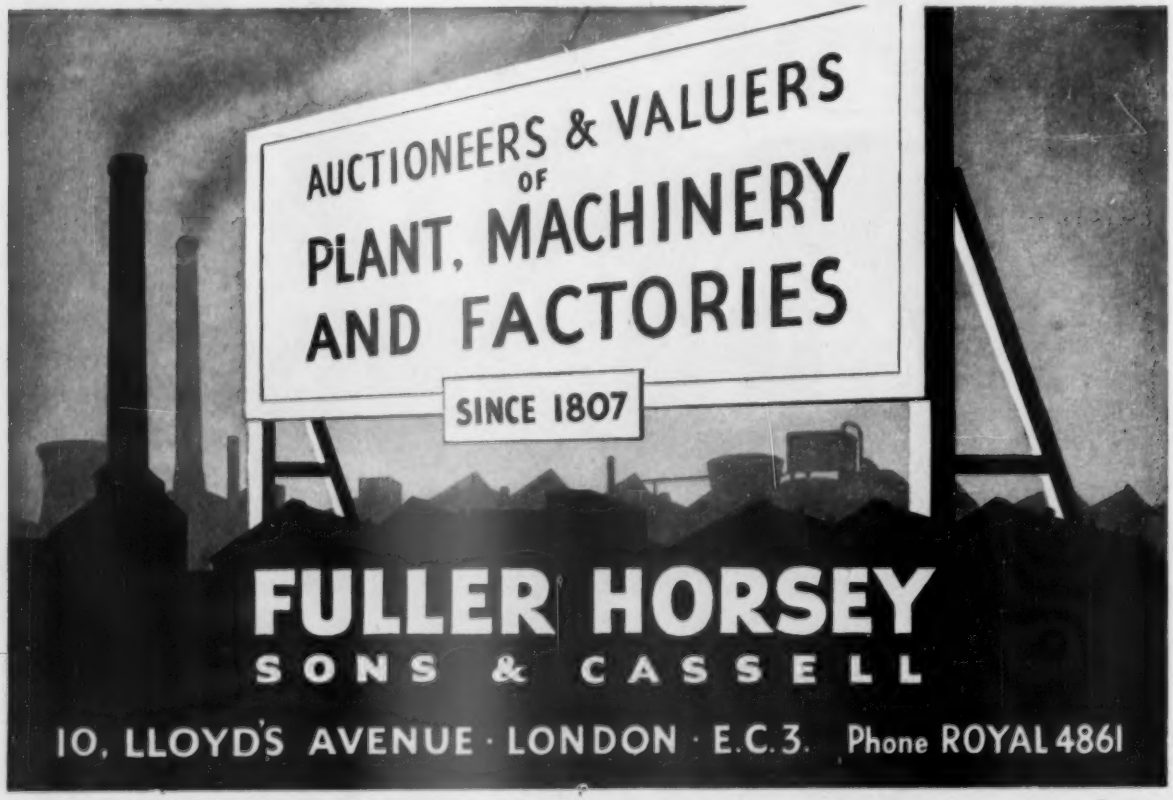

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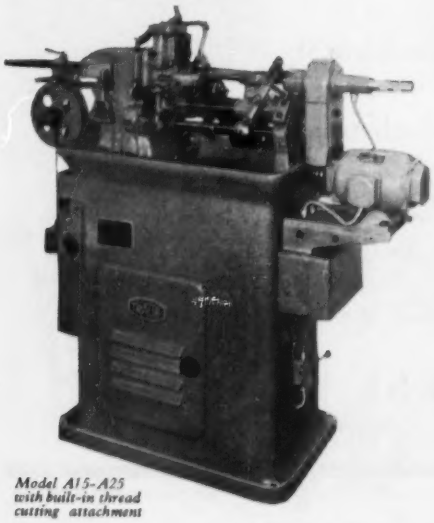

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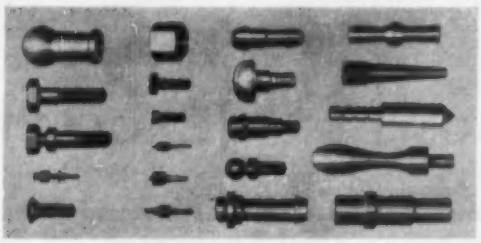

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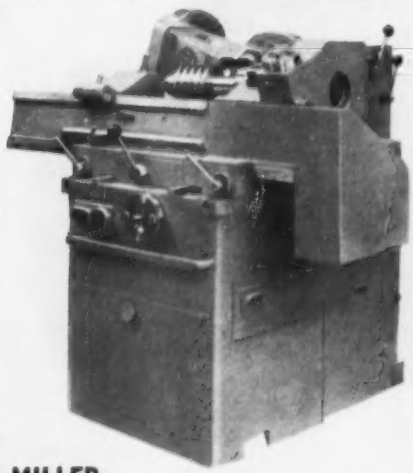

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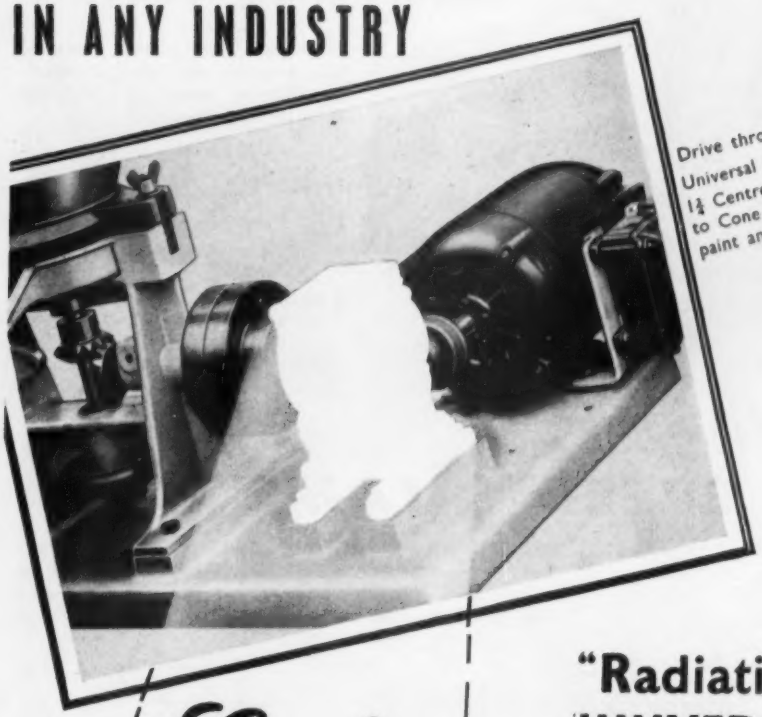

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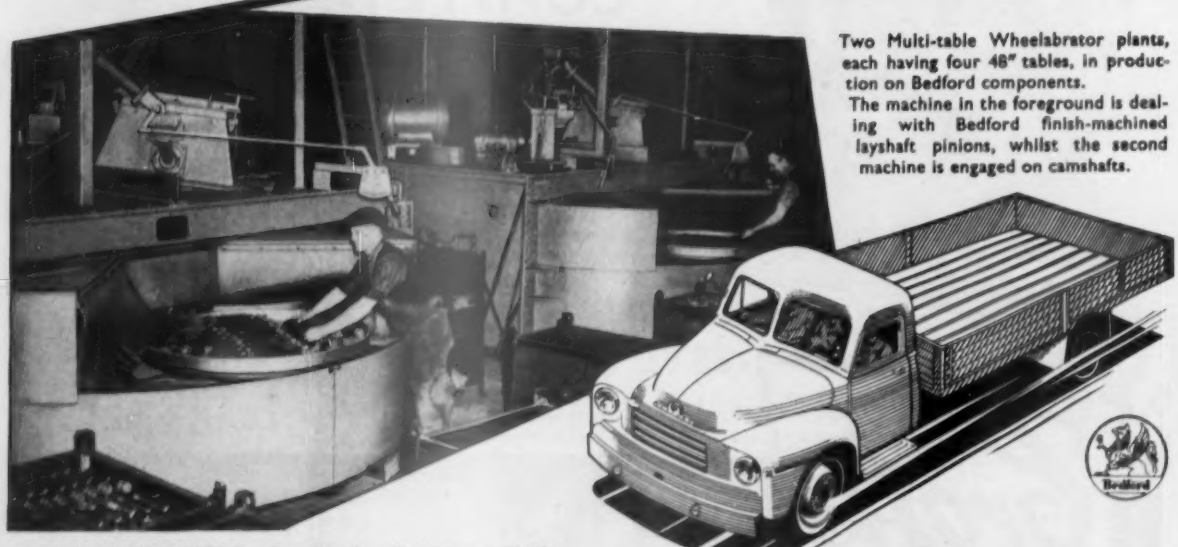

Two Multi-table Wheelabrator plants, each having four 48" tables, in production on Bedford components.
The machine in the foreground is dealing with Bedford finish-machined layshaft pinions, whilst the second machine is engaged on camshafts.

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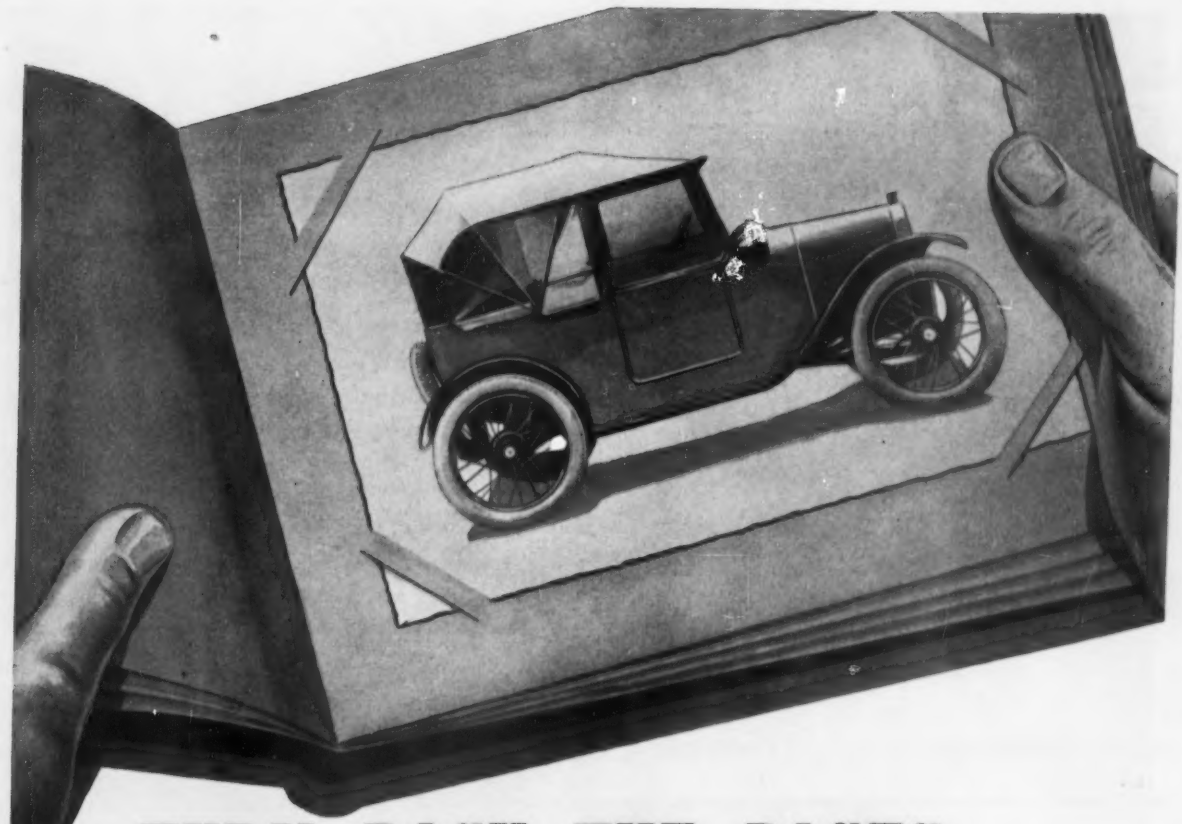

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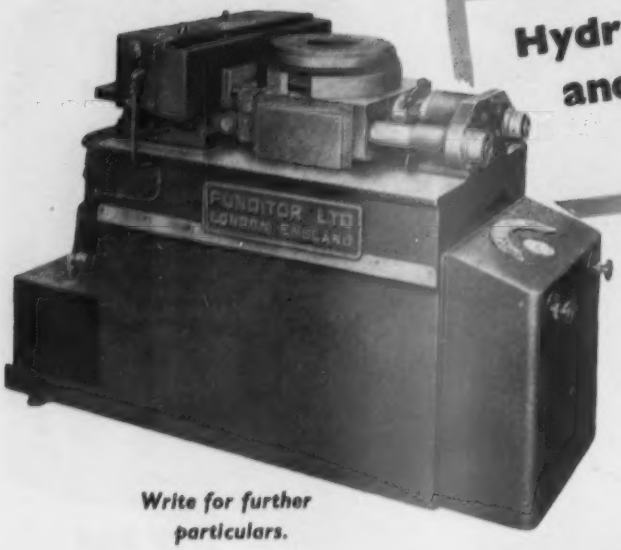

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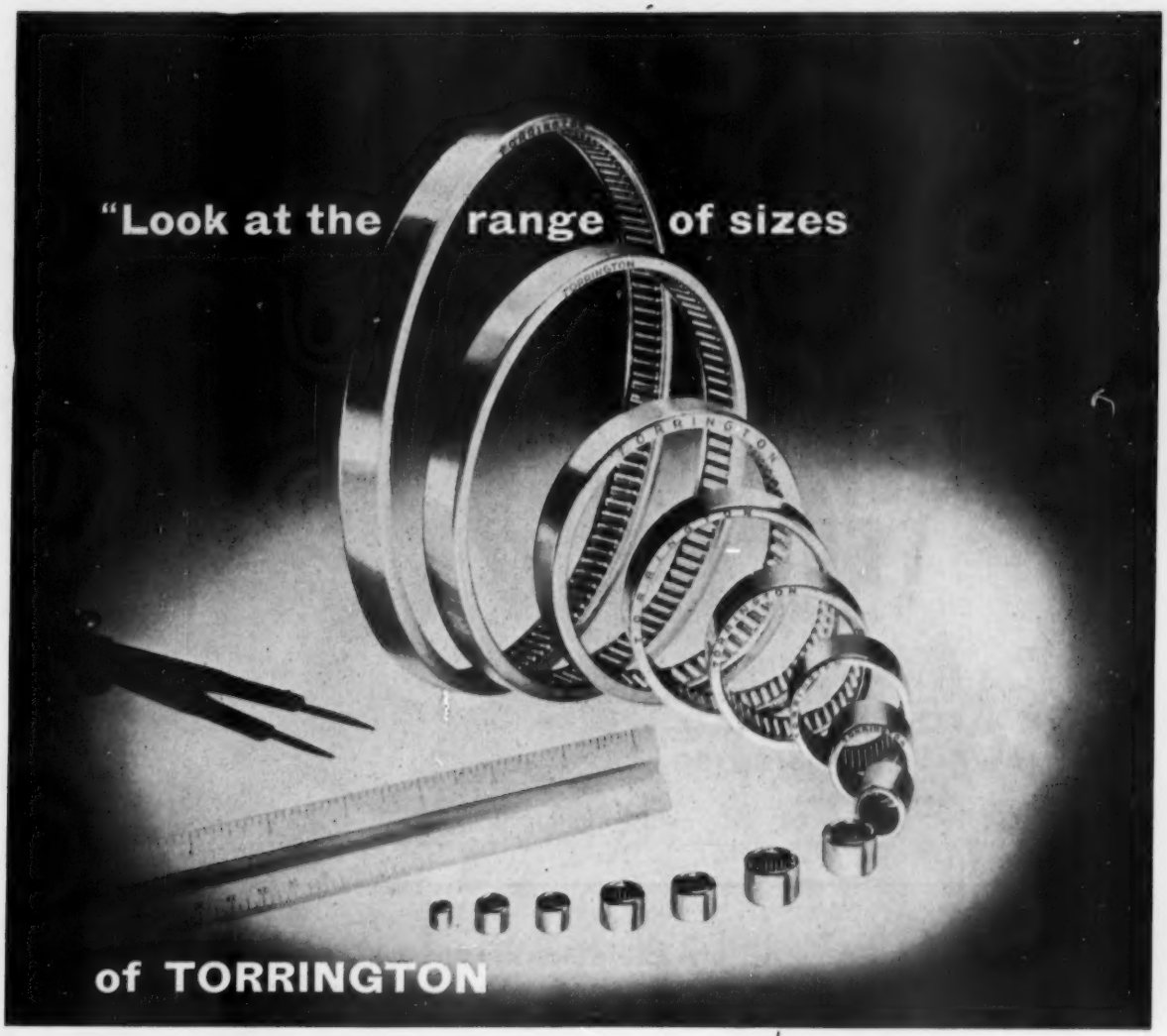

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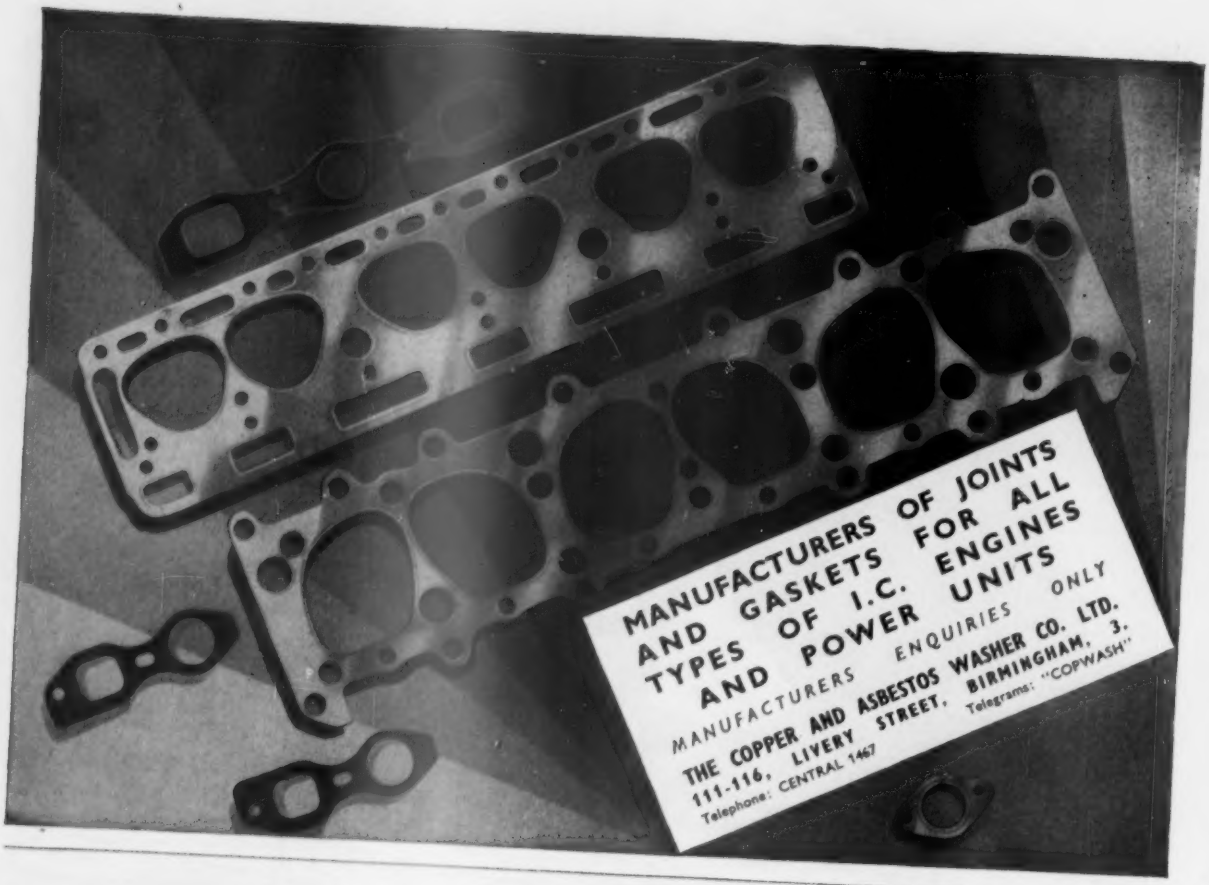
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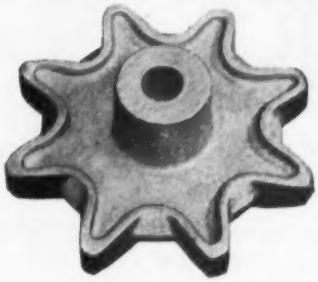

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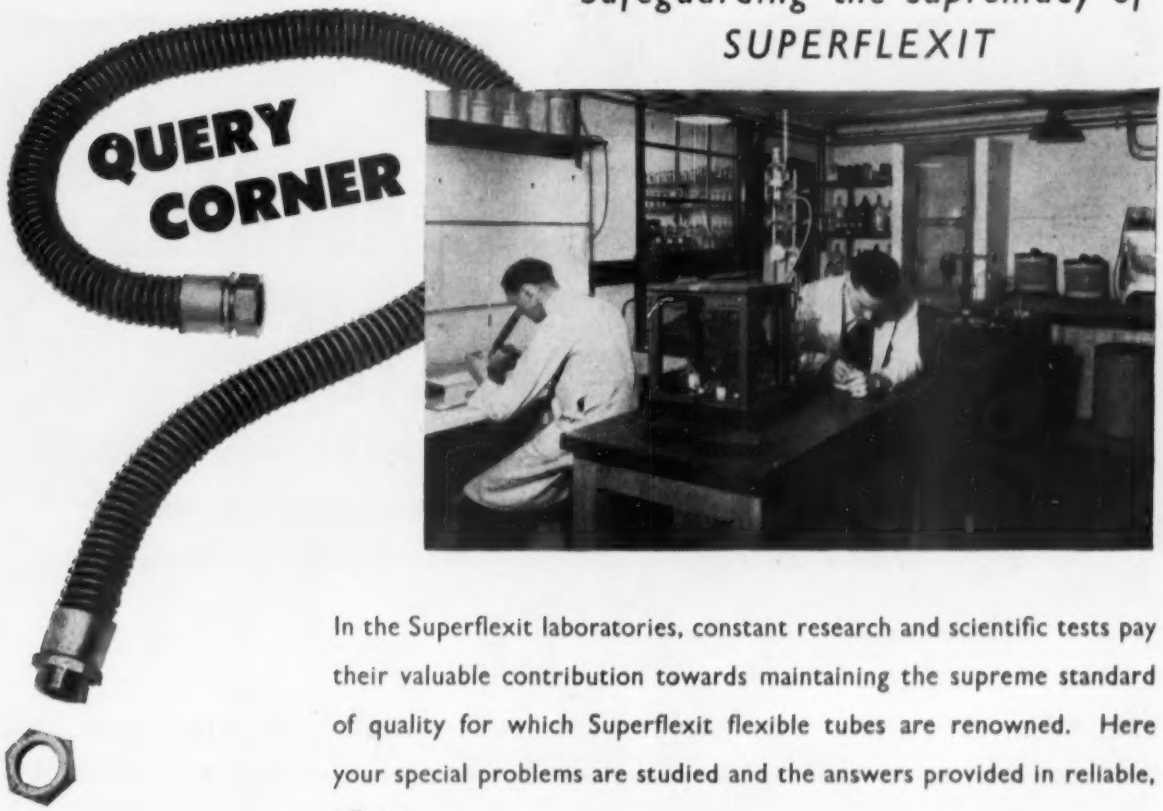

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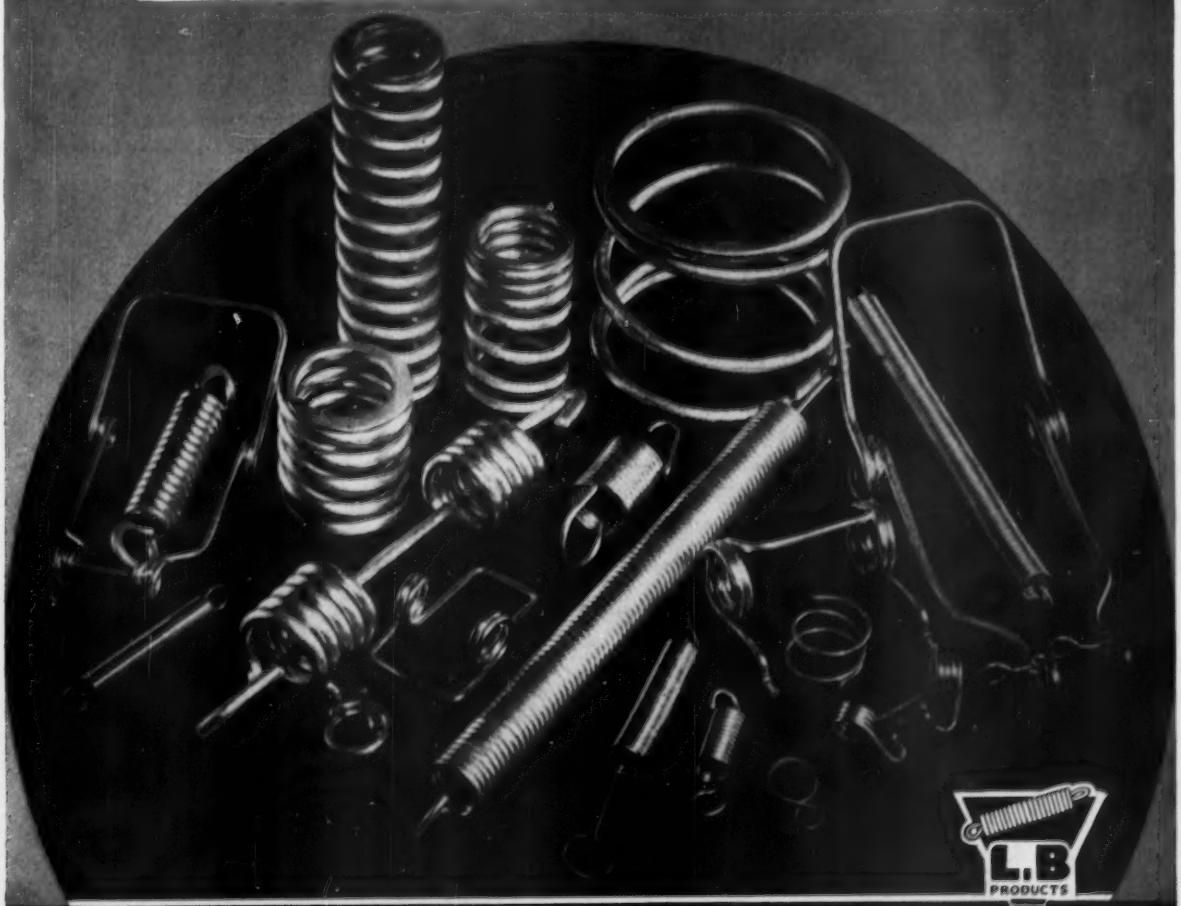

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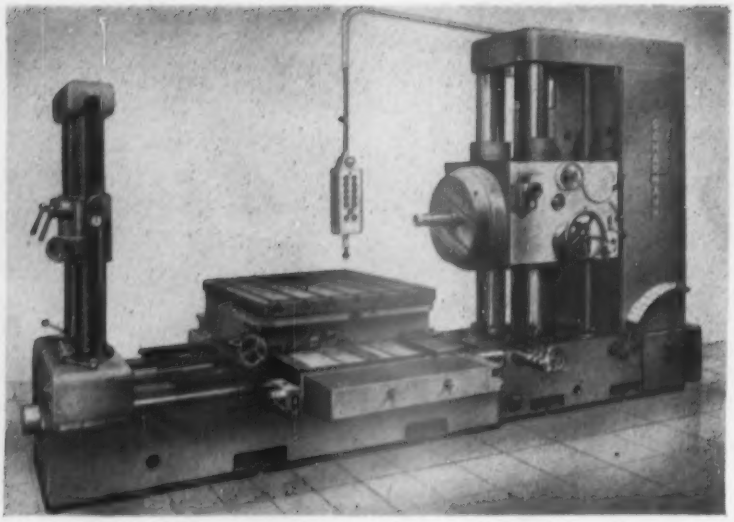

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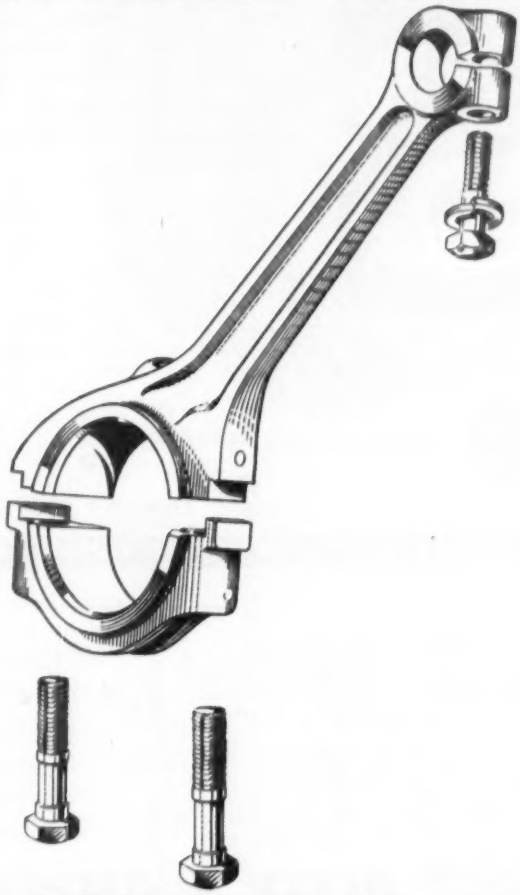

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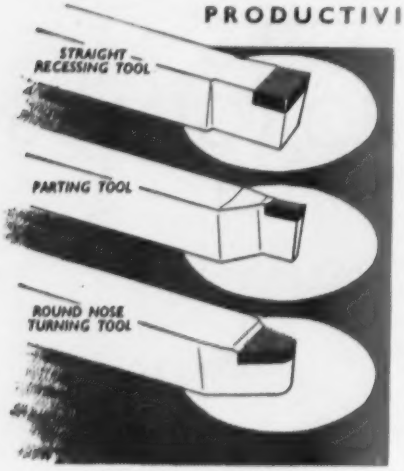

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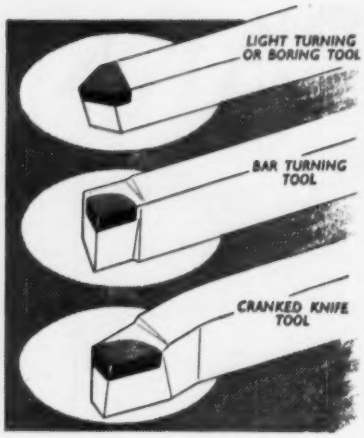

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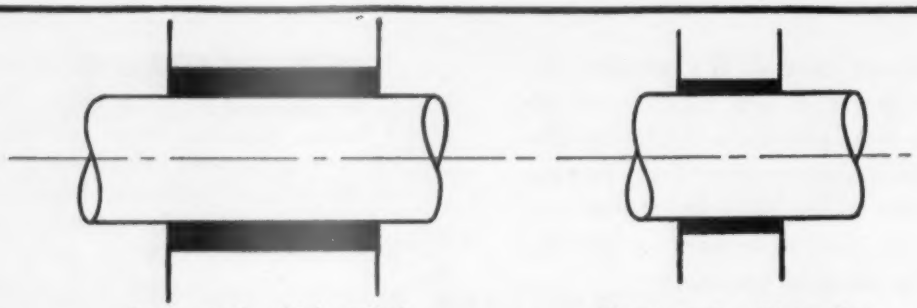

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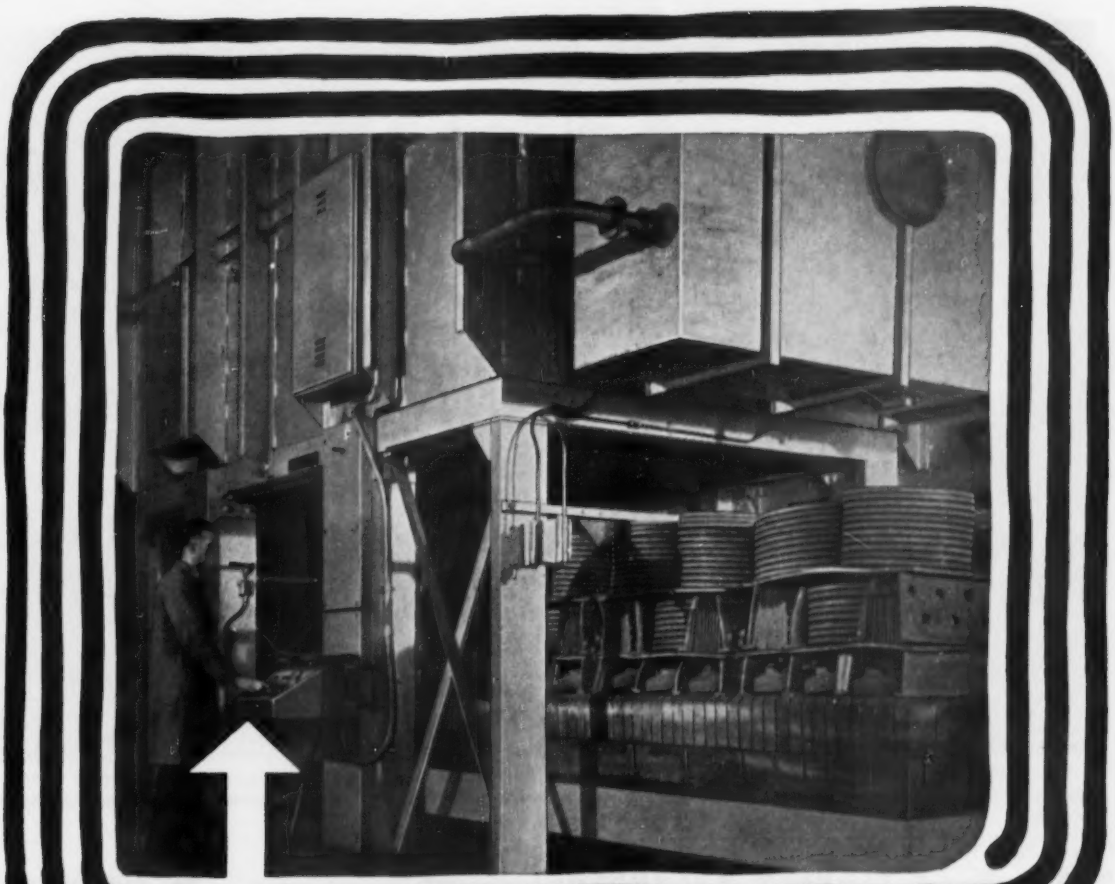

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The finger on the button, a slight movement — and into the furnace go five or more tons of castings. Like all iron castings they go in brittle, but after a cycle of heat, soak and slow cool in the controlled atmosphere, they come out malleable. Gaseous annealing in an electric furnace is quick and efficient — whereas conventional methods, involving packing in boxes, require much fuel, labour and materials. For consistent high quality in the product, for cleanliness in the works, and for low costs in the process, there is nothing like an electric annealing furnace — but it is

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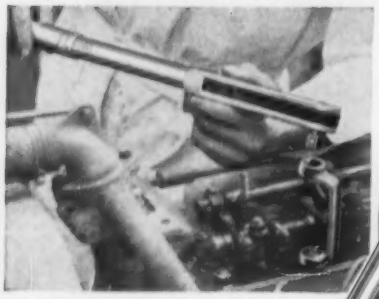

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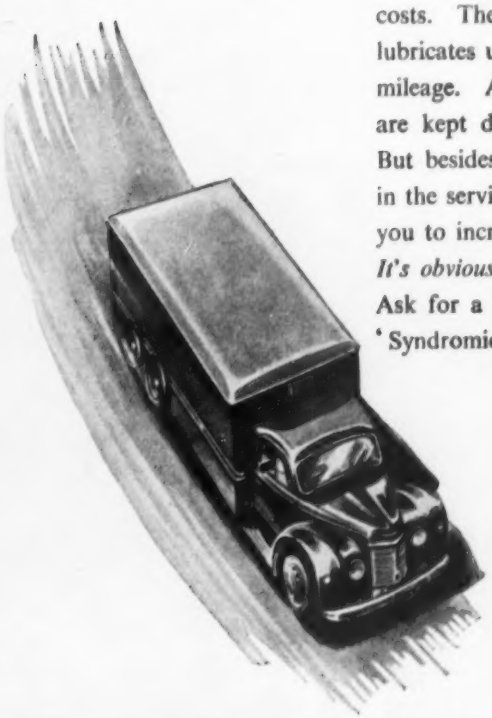

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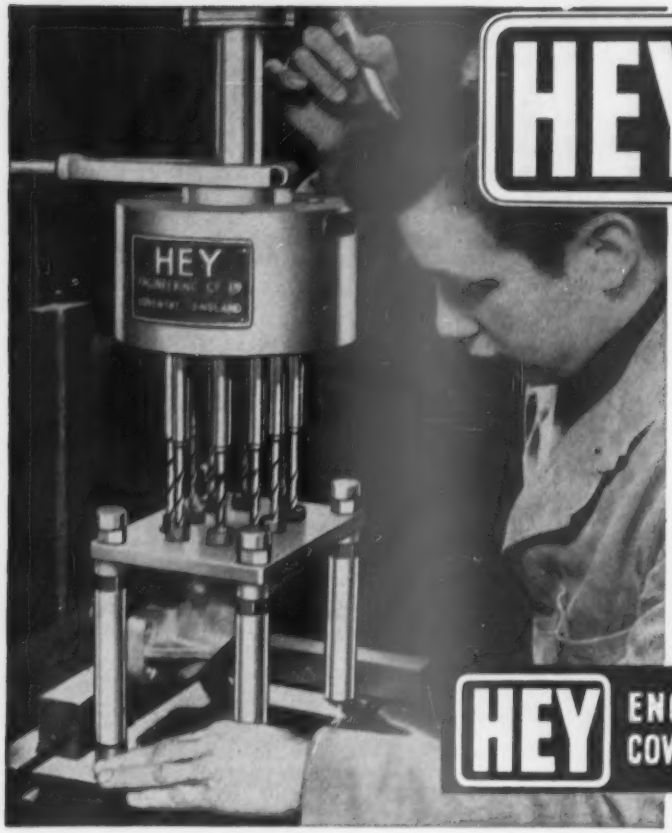

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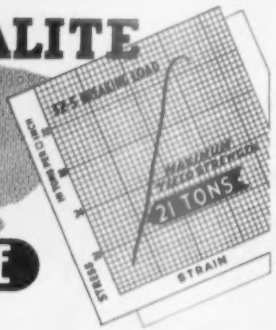

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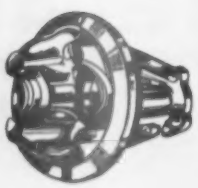

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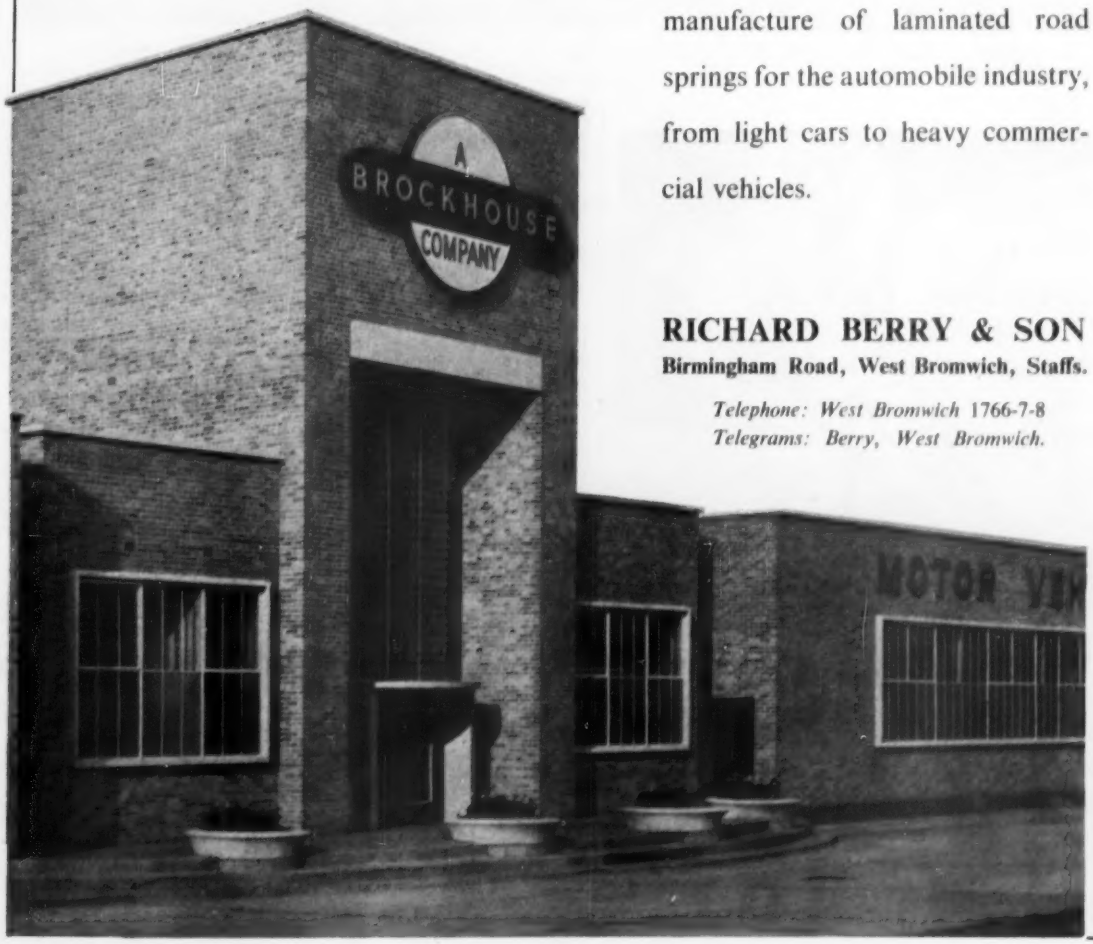

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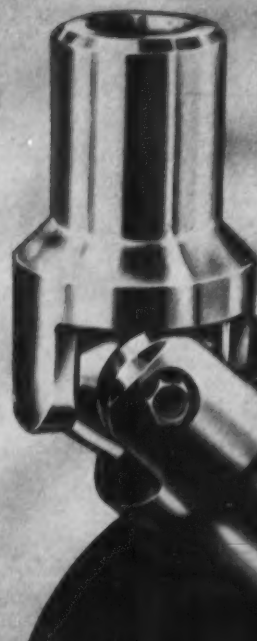

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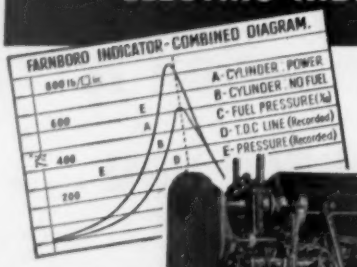

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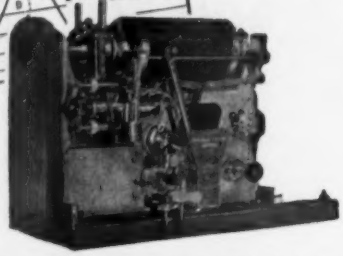

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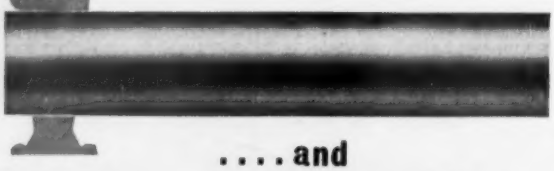

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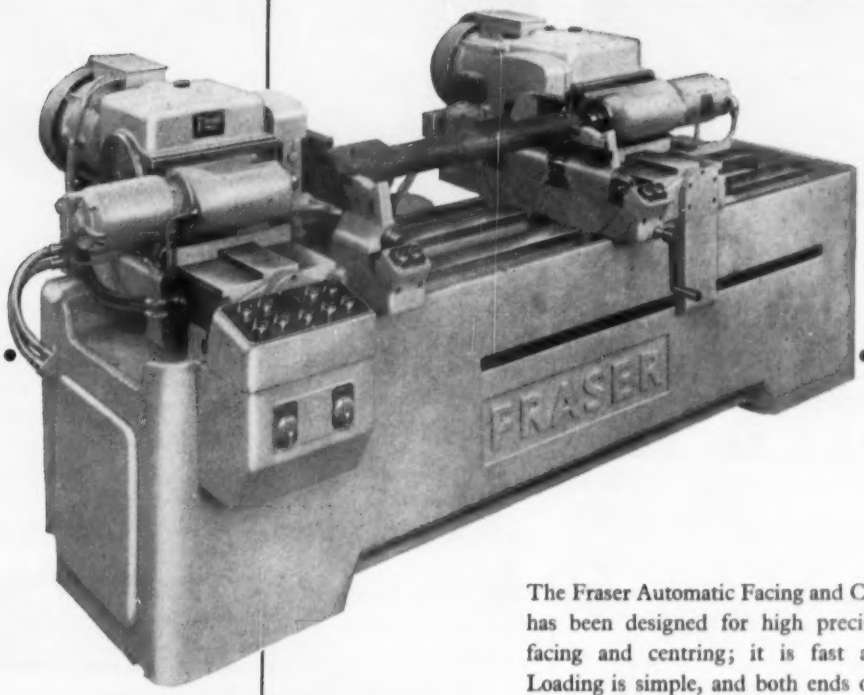

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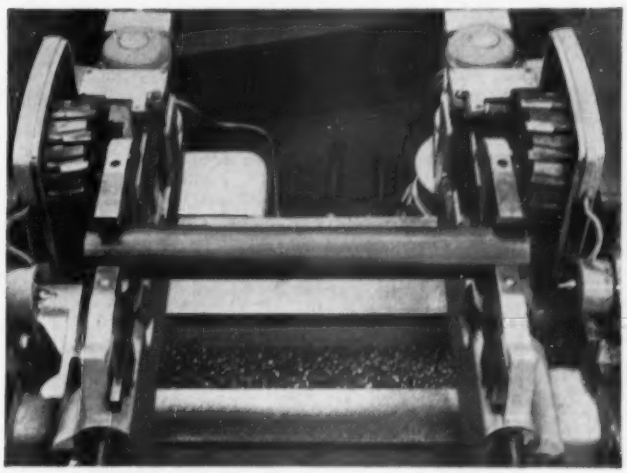

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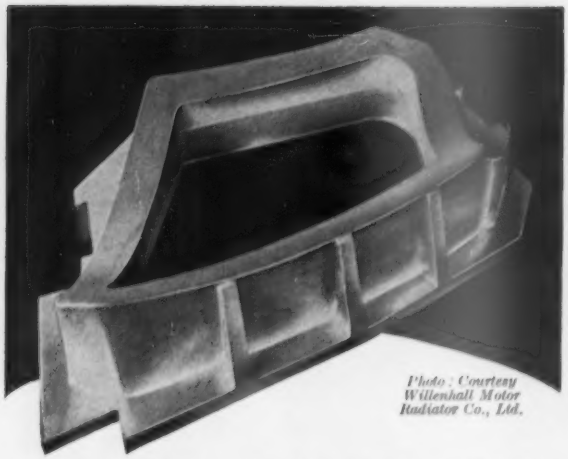

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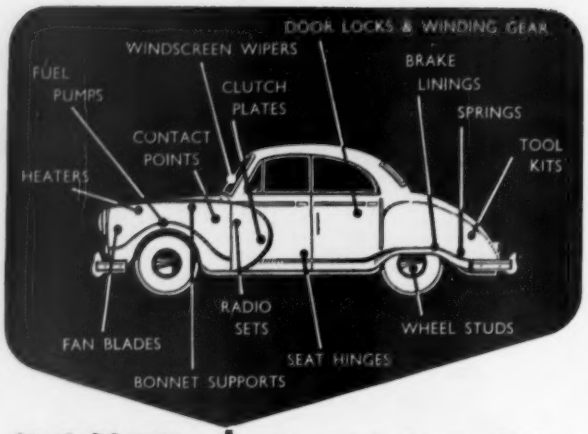

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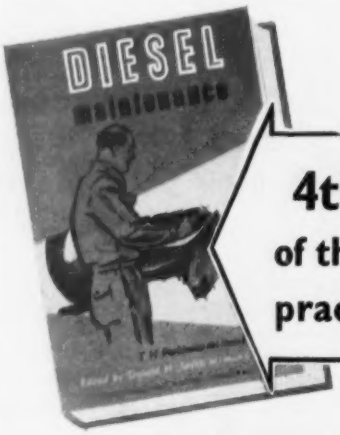

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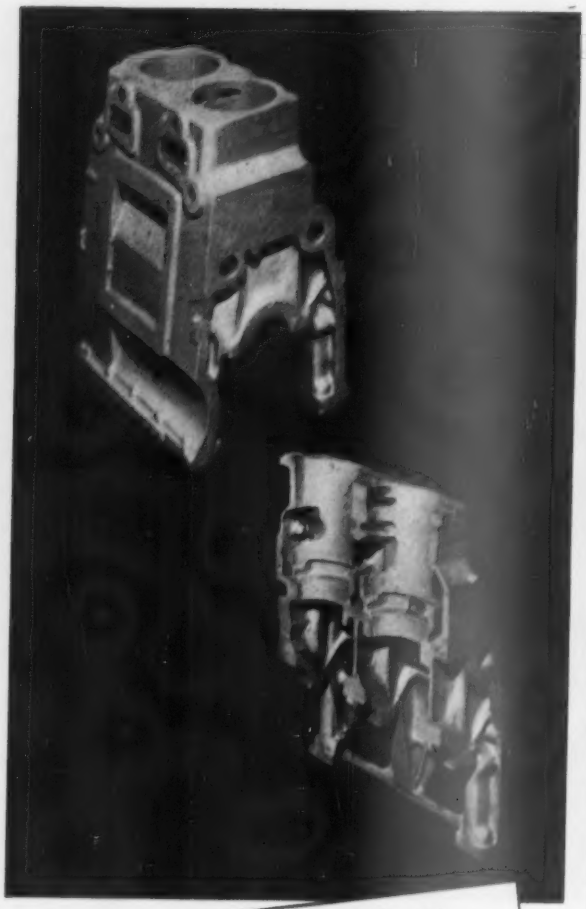

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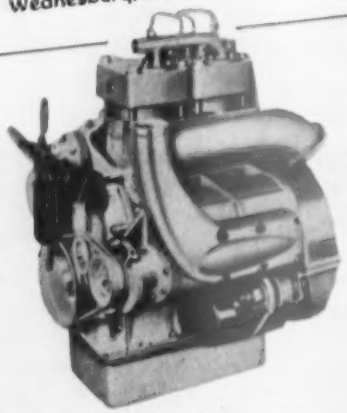

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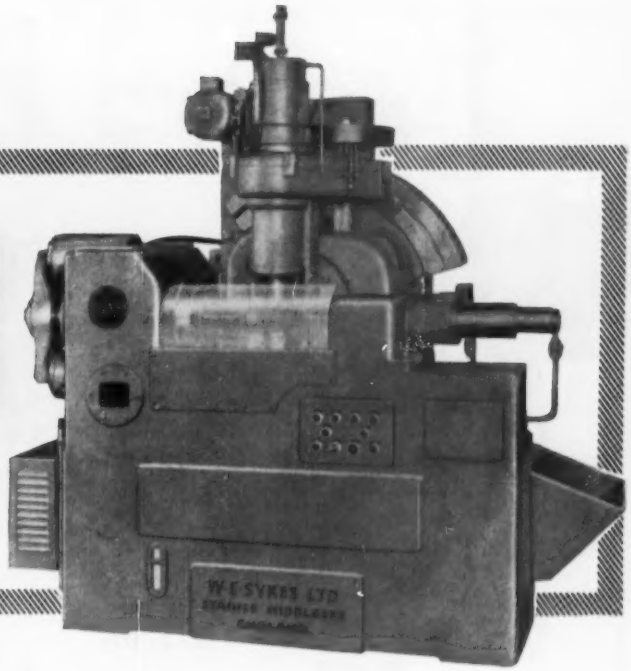

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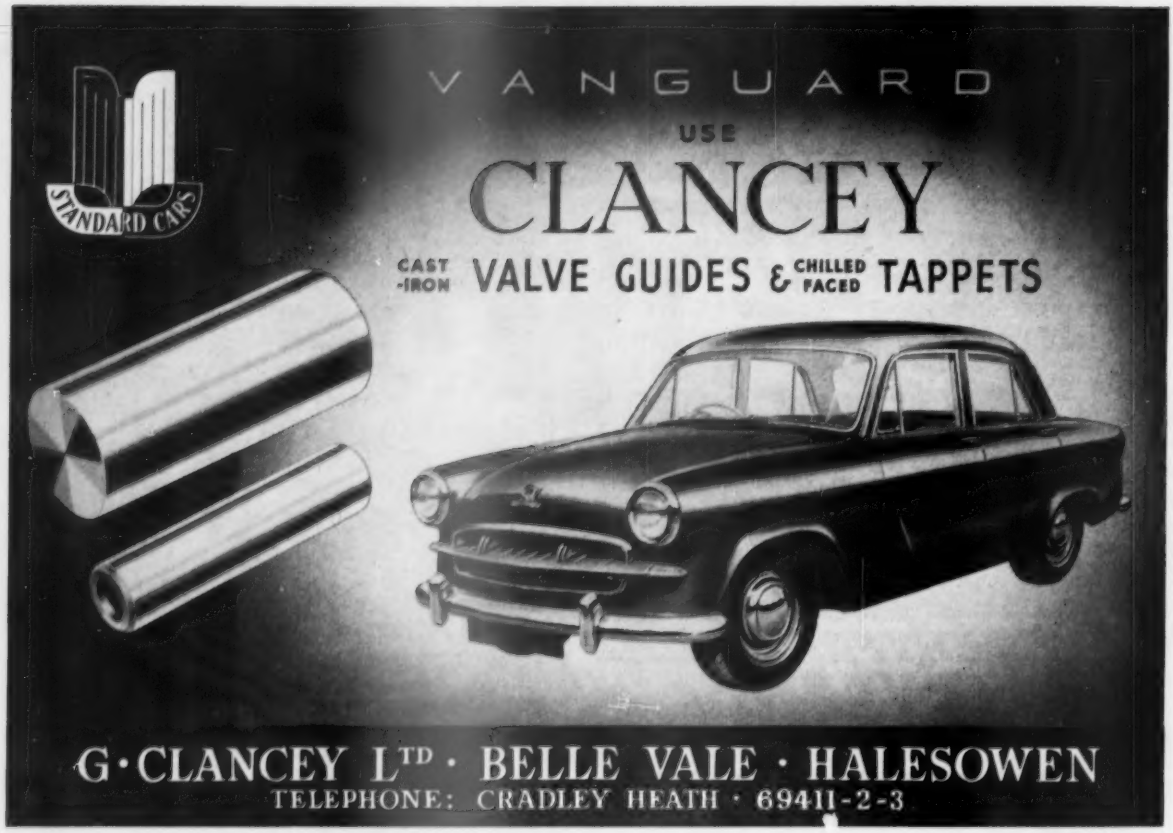

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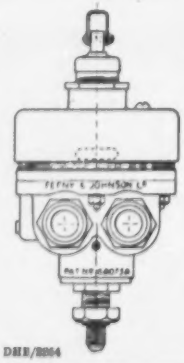

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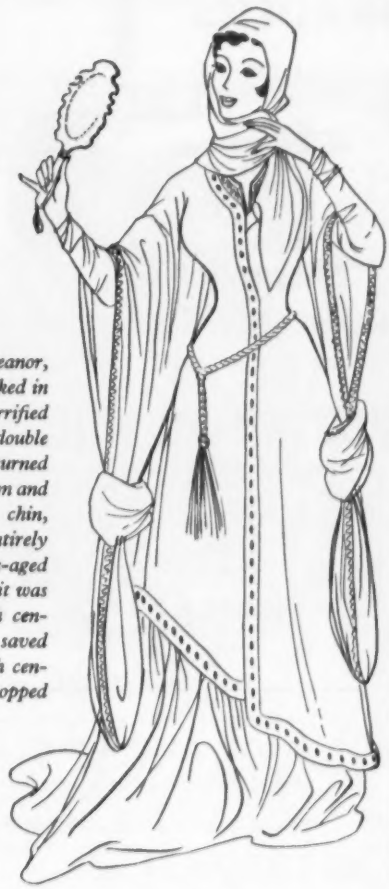

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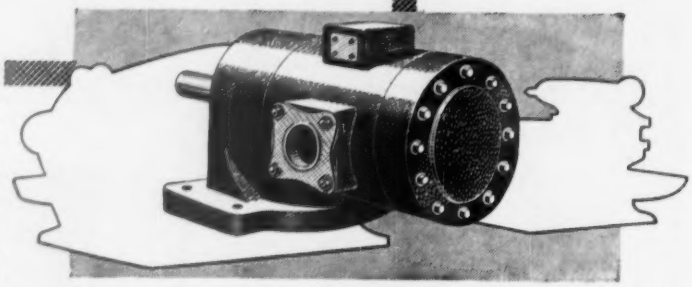

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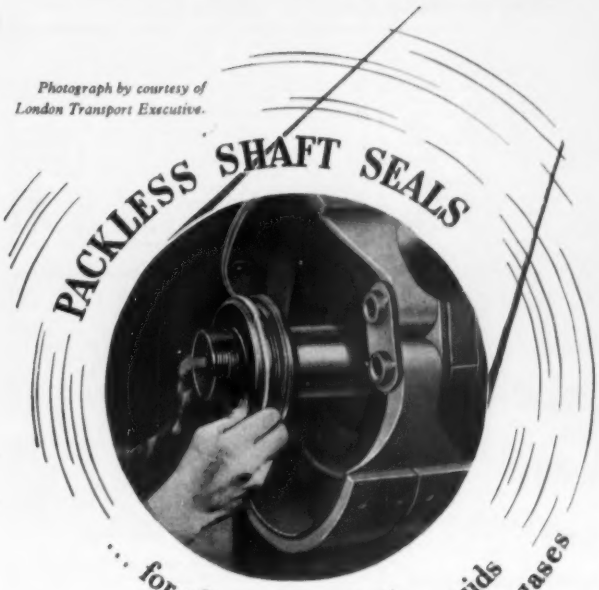

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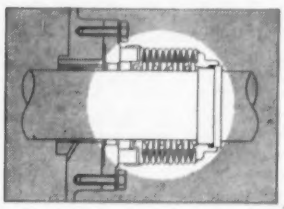

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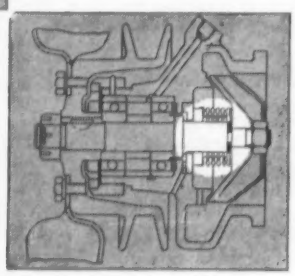

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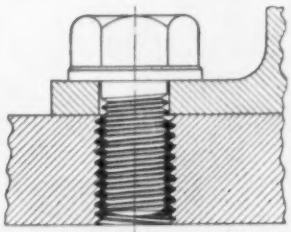

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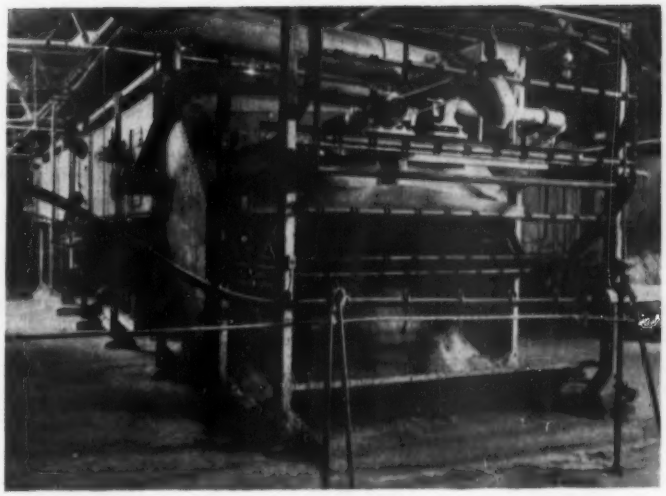

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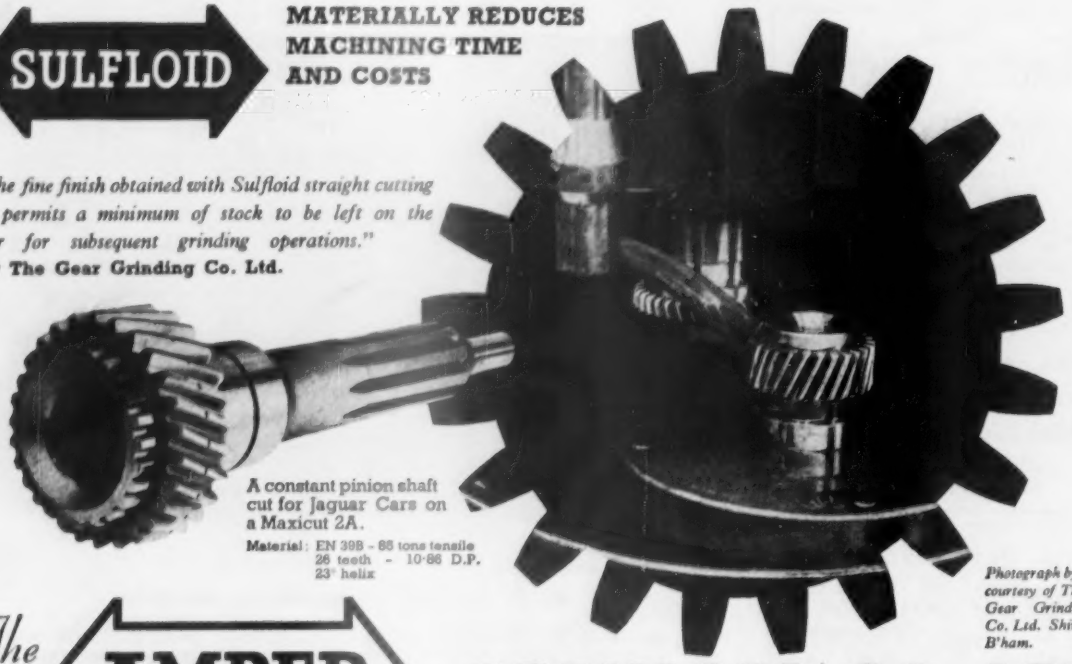

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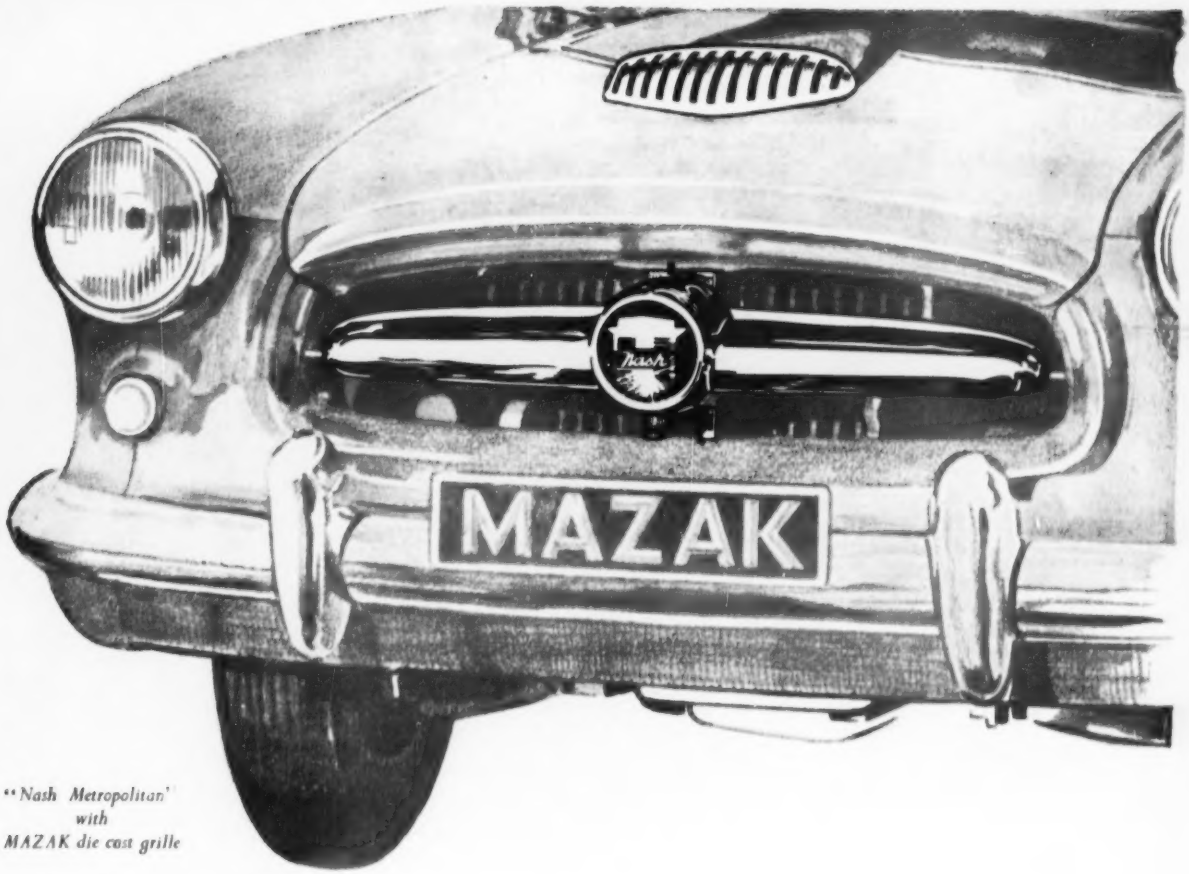

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